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Evaluation of Public Transit Automated Telephone Information Systems

Prepared for
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by
David R. Ross and Richard M. Soberman

University of Toronto - York University
Joint Program in Transportation

May 1987

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17. Abstract

The purpose of this study is to evaluate recent experience with automated telephone information systems for public transit and establish criteria and guidelines that can be employed to assess the need for, and benefits of, such systems. The experience and data acquired from a number of Canadian and U.S. demonstration projects were used to evaluate the installation and operating costs of the various systems and the benefits to the community and the transit property.

Two basic types of systems are reviewed, namely, computer assisted operator information systems and automatic schedule information systems using computer composed voice messages. The first type is designed to reduce costs and increase the efficiency of manual information systems whereas the second, in addition, is designed to increase revenue by reducing waiting time and improving the attractiveness of transit on low frequency routes.

Although the analysis points out many of the benefits and advantages of automated systems for operators, personnel, and users, it fails to reveal any clear correlation between the introduction of computer aided scheduling and increases in transit ridership.

Certain guidelines are suggested regarding the further application of these systems including recommendations that they be used on a selective basis only on low frequency routes and that, in all cases, the schedule information provided should be based on actual "real time" as opposed to schedule data.

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17. Résumé

L'objectif de la présente étude a été d'évaluer les récentes expériences d'exploitation faites sur des systèmes automatiques de renseignements téléphonés destinés aux usagers des transports collectifs, puis de formuler des critères et des lignes directrices permettant de décider de l'opportunité d'implanter un tel système et de déterminer les avantages qu'il procure. L'étude s'est fondée sur les données tirées d'expérimentations faites au Canada et aux Etats-Unis dans le but de cerner les coûts d'immobilisation et d'exploitation, ainsi que les avantages procurés tant aux usagers qu'aux entreprises de transport elles-mêmes.

L'étude a porté sur deux types de systèmes distincts: le système de renseignements téléphonés aidé par ordinateur et le système automatique d'annonces téléphonées utilisant le procédé de la synthèse de la parole. Le premier type vise surtout à réduire le coût d'exploitation et à accroître la productivité des systèmes traditionnels, alors que le deuxième vise, en outre, à stimuler les ventes en rendant les transports collectifs plus attractifs (cas des lignes à fréquence de service faible), par la réduction des temps d'attente.

L'analyse faite indique les nombreux avantages que les systèmes automatiques procurent aux exploitants, aux opérateurs et aux usagers; toutefois, elle n'a pas réussi à mettre en évidence une corrélation claire entre l'implantation d'un tel système et une augmentation de la fréquentation directement attribuable à celle-ci.

L'étude formule des lignes directrices sur l'implantation future de ces systèmes; notamment, la recommandation de ne procéder que de manière sélective dans le cas des lignes à fréquence de service faible et celle d'annoncer, dans tous les cas, les heures d'arrivée actualisées et non les heures d'arrivée prévues.

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SUMMARY

The purpose of this study is to evaluate recent experience with automated telephone information systems for public transit with a view to establishing criteria and guidelines that can be employed to assess the need for, and benefits of, such systems. The study draws heavily on data acquired from a number of Canadian and U.S. demonstration projects.

Marketing in the field of public transportation generally focuses on improving the public's perception of transit or disseminating information to potential users in an effort to stimulate demand and make it easier to use the transit system. As one of the marketing methods available, telephone information systems are readily accessible to a substantial portion of the general public and can be quickly and easily updated to reflect changes in services. Moreover, telephone information services can be personalized to suit the needs of the individual customer.

Virtually all transit authorities provide telephone information services to assist passengers in making the best use of the transit system. However, increased awareness of the importance of effective public transit marketing has resulted in efforts to improve telephone information systems to compensate for the labor intensive and high cost characteristics of the traditional manual means of communication. In particular, advances in computer technology have raised the potential for automating a number of the information functions previously performed manually.

In Canada, the first efforts to computerize transit information focused on developing fully automated schedule information systems to provide callers with stop-specific scheduled arrival times, without the need for an information agent. In the development of these systems, the principle objective was to increase the attractiveness of public transit, thereby increasing ridership, by reducing passenger waiting time and eliminating uncertainty, considered to be the most important deterrents to using public transit.

The study begins with a brief overview of the marketing function in public transportation and a short history of use of automation in these marketing services.

Chapter two then examines the experience of two large U.S. transit properties, namely, the computer assisted telephone information systems implemented by the Washington Metropolitan Transit Authority (WMATA) and the Southern California Rapid Transit District (SCRTD) in the late 1970s. The development of both systems was sponsored by the Urban Mass Transportation Administration under the Automated Transit Information Systems (ATIS) project. The basic rationale behind the ATIS program was that telephone information system efficiency could be improved through computerizing both the data storage and retrieval functions. Both projects are very similar in terms of system concept and design, although SCRTD limited the demonstration to a portion of their entire service area whereas, in the case of WMATA, total system-wide implementation was undertaken.

These computer assisted telephone information systems, which essentially mechanized information retrieval for operators, appear to have achieved their objectives in a cost-effective manner. The systems adopted by WMATA and SCRTD are most applicable to large transit authorities with complex multi-modal systems. Both properties appear satisfied that the overall benefits of their computerized information storage and retrieval systems outweigh the additional costs incurred.

Chapter three concerns the Teleride automated schedule information system. This system, as well as others recently developed in Canada, differ somewhat from the general direction taken in the United States inasmuch as the initial focus emphasizes one specific type of information request, namely, schedule information. As opposed to the U.S. systems where data storage and retrieval were automated to facilitate the manual transfer of information to customers, the Teleride system is more fully automated.

Initially, pre-recorded digitized voice tracks were used to compose an audio response to incoming calls. Subsequently, however, synthesized voice responses were developed giving much greater flexibility in the composition of schedule and service messages transmitted to callers.

In contrast to the U.S. ATIS system, where the emphasis is on reducing the cost of information systems through automation, Teleride and similar systems place more emphasis on the use of automation as a means of increasing ridership and revenue by reducing some of the uncertainty associated with waiting time at bus stops. Some of the Teleride systems provide this information on a "real time" basis, whereas others provide only regular or updated schedule information. For this reason, a significant portion of the material covered in chapter three attempts to assess the impact of automated schedule information systems on ridership and revenue in a number of locations including Winnipeg, Mississauga, Kitchener, Guelph, Salt Lake City, Pittsburg and Columbus, Ohio. In these case studies, attempts are made to examine trends in transit ridership in order to identify those increases that can be attributed to the automated schedule information system.

The final chapter of this study compares the two basic types of computer assisted information systems. The principle findings can be summarized as follows:

i) The two computer assisted information systems operated by WMATA and the SCRTD utilize computer systems to store, manipulate, and retrieve transit network and service area data. These systems function similarily to traditional manual systems, except that information agents use computer output rather than hard-copy references. Although the basic objectives of these systems are to increase agent productivity, improve the working environment, reduce overall information system operating costs, and improve service offered to the travelling public, it is difficult to quantify the benefits associated with computerized data storage and retrieval simply because neither transit property attempted to undertake a detailed cost-benefit analysis of these new systems.

ii) As opposed to computer information systems, automated schedule information systems such as Telerider provide more specific information to callers related to the arrival times of transit vehicles at particular stops. Here, the basic objective is to improve information dissemination and increase the attractiveness of public transit as a means of capturing additional revenues. However, from the sample of transit properties that have installed Telerider or similar systems, it was difficult to find any direct correlation between increases in ridership that could be attributed to the automated systems.

iii) From the sample transit properties, considerable variation in the utilization of automated passenger information systems was found which appeared to be largely related to the size of the transit system and the extent of coverage provided by the automated system. In the case of both Guelph and Brantford, for example, as well as the two U.S. properties, Telerider utilization average between 10 and 20 calls for every 1000 revenue passengers. By contrast, the Kitchener and Mississauga systems averaged 211 and 110 calls per 1000 revenue passengers respectively.

iv) The lack of any consistent capital and operating costs for the automated passenger information systems restricts systematic analysis of cost effectiveness. Operating costs varied from a low of 3.2 cents per call in Kitchener to a high of 82 cents per call in Guelph.

v) Finally, it should be noted that while many of the automated passenger information systems were originally introduced as demonstration projects, either to show how information system costs could be reduced or how automated systems could generate additional ridership, little data were collected in these demonstrations to allow for any statistical analysis of the correlation between the implementation of automation and effects on ridership.

Despite the relatively scant information available for a systematic analysis of the impacts of automation on either the costs of information systems or on the generation of additional ridership, it is possible to suggest a number of guidelines that might be followed in future applications of this type of technology:

1. Computer assisted systems used to supplement manual information systems should be evaluated in terms of their primary contribution to cost reduction, that is, as a means of increasing operator productivity. The basic issues to be considered relate to the extent to which these improvements in productivity allow more calls to be handled at a given level of expenditure (by requiring fewer lines and operators) and the extent to which they reduce the service time per caller (thereby encouraging greater use of the service).

2. Automated schedule information systems should be considered only for routes with modest to low frequency of service where long waiting times are seen to be a deterrent to potential ridership. These systems should probably not be considered for application to routes characterized by high frequency service where waiting times average less than 7.5 minutes (that is 15-minute scheduled headways).

3. As a corollary of 2, above, even for large systems involving multi-modal services, automated schedule information systems should be applied on a selective basis rather than a system-wide basis to meet these criteria.

4. In terms of contribution to increased ridership and revenue, automated schedule information systems should be integrated with vehicle monitoring systems so as to provide "real time" as opposed to schedule arrival information. The integration of these two systems, of course, provides additional benefits related to operational efficiency and flexibility for service adjustments such as short-turning.

5. Because the cost-effectiveness of automated schedule information systems in generating additional revenue has yet to be clearly demonstrated, the introduction of such systems should also be assessed in terms of other benefits and possibilities for cost reduction, including those related to vehicle maintenance and scheduling, and reductions in the costs of passenger information services (recognizing that separate but less extensive services will still be required for route planning information).

SOMMAIRE

L'objectif de la présente étude a été d'évaluer les récentes expériences d'exploitation de systèmes automatiques de renseignements téléphonés destinés aux usagers des transports collectifs, et de formuler des critères et des lignes directrices permettant de décider de l'opportunité d'implanter un tel système et de déterminer les avantages qu'il procure. L'étude s'est fondée en très grande partie sur les données tirées d'expérimentations faites tant au Canada qu'aux Etats-Unis.

Pour attirer le public voyageur et l'inciter à emprunter les transports collectifs, les organismes concernés cherchent, d'une part, à redorer la perception que ce public a des transports collectifs en général et, d'autre part, à lui faciliter la tâche en lui fournissant tous les renseignements dont il a besoin. Une des méthodes utilisées est le service de renseignements téléphonés qui, en plus d'être accessible au grand public, est très simple à actualiser pour tenir compte des changements. Ce service offre l'avantage supplémentaire de pouvoir être adapté au goût particulier du client.

Pratiquement toutes les entreprises de transports collectifs offrent un service de renseignements téléphonés voyageurs. Toutefois, une conscience plus aiguë des effets bénéfiques qu'apporte une image de marque flatteuse a incité les entreprises à se doter d'un service de renseignements téléphonés qui soit non seulement efficace, mais qui ne souffre plus des inconvénients (coût élevé, main-d'oeuvre nombreuse) des systèmes traditionnels. Ainsi, elles tablent de plus en plus sur les progrès de l'informatique pour automatiser des tâches jusqu'ici manuelles.

Au Canada, les premiers efforts dans ce domaine ont été consacrés à la mise au point de systèmes d'annonces automatiques téléphonées sur les heures d'arrivée à une destination spécifique, dispensant du besoin d'un intermédiaire humain. L'objectif principal était d'accroître l'attractivité des transports collectifs et, partant, la fréquentation, en réduisant les temps d'attente, facteur dissuasif de premier plan.

Le chapitre 1 de l'étude est consacré à une brève explication de la fonction "Ventes" vue par un organisme de transports collectifs et à un rappel historique du rôle confié à l'automatisation comme moyen de stimuler les ventes.

Le chapitre 2 traite des résultats obtenus par deux gros organismes de transports collectifs aux Etats-Unis: Washington Metropolitan Transit Authority (WMATA) et Southern California Rapid Transit District (SCRTD) qui, tous deux, vers la fin des années 70, ont utilisé un système de renseignements téléphonés aidé par ordinateur. La mise au point des deux systèmes avait été assurée grâce au concours de l'Urban Mass Transportation Administration, aux termes du programme Automated Transit Information Systems (ATIS). L'idée sous-tendant ce programme est que la productivité d'un système de renseignements téléphonés peut être relevée par l'informatisation des fonctions stockage et rappel des données. Ces deux systèmes sont de conception et de réalisation semblables, sauf que le SCRTD n'y a converti qu'une partie de son réseau, alors que la WMATA y est allée à fond.

Tout porte à croire que les deux systèmes en question, qui soulagent l'opérateur par une gestion mécanique de l'information, ont atteint les objectifs fixés d'efficacité et de coût. Ils sont éminemment adaptables aux grosses entreprises de transport en commun qui exploitent un réseau multimode complexe. Quoiqu'il en soit, tant la WMATA que le SCRTD sont convaincus que les gains d'une gestion automatique des données l'emportent sur les coûts supplémentaires consentis.

Le chapitre 3 de l'étude traite du système automatique d'annonces téléphonées appelé Telerider qui, avec d'autres systèmes récemment étudiés au Canada, divergent quelque peu des systèmes implantés aux Etats-Unis du fait qu'ils sont axés au départ sur l'annonce d'un renseignement bien spécifique: l'horaire. Contrairement aux systèmes américains où seules les fonctions de stockage et de rappel des données ont été informatisées, l'information étant toujours transmise de vive voix, le système Teleride est beaucoup plus automatisé.

Au début, des signaux vocaux préenregistrés et numérisés servaient à composer la réponse vocale à un appel téléphonique. Par la suite, cependant, on s'est servi du procédé de synthèse de la parole pour former des réponses caractérisées par une souplesse beaucoup plus grande dans la composition des renseignements transmis.

Contrastant avec le système américain ATIS qui utilise l'automatisation pour réduire le coût de l'information transmise, le système Teleride et d'autres lui ressemblant utilisent l'automatisation comme moyen d'atténuer le facteur dissuasif (temps d'attente à une station d'autobus par exemple) et, par là, parvenir à augmenter la fréquentation et stimuler les ventes. L'information sur l'heure d'arrivée à une station peut être donnée soit en temps réel soit en différé avec actualisation à intervalle régulier. Une bonne partie du chapitre 3 est consacrée à évaluer l'impact du système automatique d'annonces téléphonées sur la fréquentation et les recettes dans un certain nombre de villes où il a été implanté: Winnipeg, Mississauga, Kitchener, Guelph, Salt Lake City, Pittsburgh et Colombus (Ohio). Dans chacun de ces cas, l'étude a cherché à dégager les tendances de la fréquentation et à trouver la part de l'augmentation attribuable à l'implantation du système d'annonces.

Enfin, dans le dernier chapitre, l'étude fait le bilan comparatif des deux systèmes, dont les principales conclusions peuvent être résumées comme suit:

i) Dans les deux systèmes d'information assistés par ordinateur implantés par la WMATA et le SCRTD, la partie informatique sert au stockage, à la gestion et au rappel des données intéressant soit le public, soit les services internes. La communication des renseignements se fait de façon traditionnelle, sauf que, au lieu de consulter des données sur papier, les opérateurs utilisent les sorties d'ordinateur. Même si l'objectif fondamental de l'implantation de ces systèmes était de relever la productivité, d'améliorer les conditions de travail, de réduire les coûts directs et de fournir un service voyageurs amélioré, il est malaisé de chiffrer les avantages qu'ils ont apportés, aucun des deux organismes visés n'ayant véritablement cherché à vérifier le rapport avantages-coût du système adopté.

ii) Contrairement aux systèmes informatisés, les systèmes automatiques d'annonces téléphonées, tel le Telerider, fournissent des renseignements spécifiques, comme: heure d'arrivée à une destination donnée. Dans ce cas, l'objectif principal est de rendre les transports collectifs plus attractifs par une meilleure diffusion de l'information, de manière à stimuler les ventes. Cependant, dans l'étude des organismes échantillonnés ayant adopté le système Telerider ou un système analogue, il s'est avéré difficile de trouver une corrélation directe entre les augmentations constatées dans la fréquentation et l'implantation du système automatique.

iii) Dans les organismes échantillonnés ayant fait appel à un système automatique d'annonces téléphonées, des écarts considérables ont été relevés dans le taux d'utilisation de ce système, écarts dont on peut dire qu'ils sont reliés à la taille de l'organisme utilisateur et à la pénétration du système dans le réseau téléphonique. Ainsi, dans le cas de Guelph et de Brantford, par exemple, de même que dans celui des deux organismes américains cités, le Telerider intervient en moyenne de 10 à 20 fois par millier de voyages payés, contrastant avec la moyenne de 211 et de 110 par millier de voyages payés, dans le cas des villes de Kitchener et de Mississauga, respectivement.

iv) L'absence de données cohérentes sur les coûts d'immobilisation et d'exploitation des divers systèmes automatiques de renseignements téléphonés inhibe toute analyse systématique du rendement. Quant aux coûts d'exploitation, ils fluctuent entre un minimum de 3,2 cents par appel dans le cas de Kitchener et un maximum de 82 cents pour Guelph.

v) Enfin, il y a lieu de remarquer que même si l'implantation des systèmes automatiques visait initialement à démontrer leur possibilité soit de réduire le coût d'exploitation, soit de stimuler les ventes, trop peu de données ont été rassemblées pour permettre d'analyser statistiquement la corrélation entre l'automatisation du service et ses effets sur la demande de transports.

Néanmoins, malgré cette lacune, il est possible de suggérer des lignes directrices à suivre dans l'implantation future d'un système relevant de cette technologie:

1. Avant d'implanter un système assisté par ordinateur utilisé en relève du service assuré par des opérateurs, évaluer la réduction probable du coût d'exploitation, c'est-à-dire le gain de productivité. Il s'agit avant tout de déterminer dans quelle mesure l'accroissement dans la productivité se traduit par un accroissement dans le nombre d'appels traités par tranche de coût donnée (réduction des lignes téléphoniques et de la main-d'oeuvre), ainsi que par une rapidité accrue du traitement de chaque appel reçu, d'où une intensification du service.

2. Ces systèmes devraient être implantés sur les lignes où la fréquence de service va de faible à moyenne, c'est-à-dire là où les temps d'attente sont relativement longs, décourageant la fréquentation. Il n'y aurait peut-être pas lieu de les implanter sur les lignes à fréquence élevée, là où le temps d'attente pour le plus grand nombre de voyageurs se situe autour de $7\frac{1}{2}$ minutes (intervalle de 15 minutes).

3. Corrollairement à ce qui précède, même dans le cas d'un réseau vaste comportant des services multimodes, implanter un système automatique d'annonces téléphonées selon les critères énoncés, et non sur tout le réseau.

4. Dans le but d'accroître la fréquentation et de stimuler les ventes, intégrer les systèmes automatiques d'annonces aux systèmes de suivi des véhicules, de manière à annoncer des heures d'arrivée actualisées, par opposition aux heures prévues. Une telle intégration serait également bénéfique au niveau des opérations, tout changement imprévu, comme la mise en service d'une navette courte, pouvant être rapidement programmé et annoncé.

5. Etant donné que l'efficacité des systèmes automatiques d'annonces à générer des recettes supplémentaires n'a pas encore été clairement établie, évaluer ces systèmes en termes d'avantages supplémentaires et de réduction d'autres types de coûts, notamment ceux reliés à la programmation des départs et à la maintenance des véhicules et aux services d'annonces téléphonées voyageurs, étant entendu qu'il faudra prévoir un service d'information séparé, quoique moins étendu, pour la préparation des itinéraires.

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1. Introduction

1.1 Objectives

The purpose of this study is to evaluate recent experience with automated telephone information systems for public transit and establish criteria and guidelines that can be employed to assess the need for, and benefits of, such systems.

1.2 Background

In recent years it has become widely accepted that, like other industries, the transit industry is in the business of selling a service to its customers. The growing realization that public transit had to "sell" itself to the general public emerged in the 1960s and 1970s in response to rapidly rising costs and sharply declining ridership. In the early years, public transit was seen as a service for those who had no other means of transport within an urban area. The rapid growth in private automobile ownership in the 1950s and 1960s severely eroded the traditional demand base for public transit. At the same time, continuing urbanization forced public transit operators to service larger areas while losing ridership to the private automobile.

Faced with this changing urban environment, public transit authorities were forced to actively compete with the private automobile for passengers. Their plight was somewhat ameliorated by growing traffic congestion and parking problems, especially in the downtown areas of the larger cities. The advantage that public transit gained in serving the downtown areas, however, was more than offset by the growing decentralization of employment to the urban fringe. These lower density employment areas, with ample space for parking, were more easily served by the private automobile. Nevertheless, public transit authorities were bound to serve these areas to provide for those who needed public accessibility to employment opportunities. By the 1970s, public transit authorities found themselves in the position of providing service to a very large area of relatively low density residential and employment development. In addition, they were essentially providing a bi-directional service for a uni-directional demand.

Efforts directed at making public transit an attractive alternative to the private automobile initially focused on increasing both system coverage and frequency of service. As transit systems matured and further system expansion became prohibitively expensive, more cost-effective means of stimulating demand were sought. This led to more aggressive marketing of public transit as a service to the travelling public, focusing on changing attitudes toward public transit and disseminating information to potential users.

1.3 Marketing Transit Services

There are a variety of media at the transit authority's disposal to market their services to the general public. These include radio, television and newspaper advertisements and news bulletins, printed route maps and schedules, and telephone information services. Marketing activities generally focus on improving the public's perception of transit or disseminating information to potential users in an effort to stimulate demand and make it easier to use the system.

The focus of marketing effort and the level of detail attainable is dependent upon the selected medium. Radio, television and newspaper advertisements and news bulletins are capable of reaching large audiences and are used primarily to promote the general benefits of public transit, inform the public of basic service characteristics and changes, and advertise special services (e.g., express buses to baseball games or other special events). In these media approaches, any information provided is unsolicited and has a very short life-span and, for this reason, must be kept very general to be of relevance to such a large audience.

Printed material distributed by the transit authority ranges from system-wide route maps with information on hours of service, fares, etc., to route-specific maps and schedules. While this type of information is quite detailed and can be retained by the transit user for future reference as required, it is often difficult to obtain and not easily understood, especially for the larger, more complex systems. In addition, the material must be updated as services and schedules are altered.

A telephone information service has several distinct advantages over other media for information dissemination. It is readily accessible to a substantial portion of the general public and can be drawn upon as the need arises. In addition, it can be quickly and easily updated to reflect changes in service. This is particularly advantageous following major system changes, short-term, or emergency, re-routing of transit vehicles. Finally, and most importantly, a telephone information service can be personalized to suit the needs of the individual customer.

Although telephone systems are the most complete source of detailed transit information, they cannot stand alone as a passenger information system. The information is provided verbally and, therefore, has a short life. Unlike a timetable, it cannot be referred to again enroute. The extremely specific nature of the information limits its transferability, requiring the user to make another call if a change in itinerary or travel time is planned.

1.4 History of Automation in Public Transit Telephone Information

Virtually all transit authorities provide a telephone information service to assist passengers in making the best use of the transit system. The degree of system sophistication varies with the size and complexity of the transit system. In smaller properties, office staff may be responsible for answering telephone inquiries as part of their general clerical duties during normal working hours. In the larger properties, where the transit system is more complex, specially trained information agents are usually dedicated to the information system, sometimes providing 24-hour service to the general public.

Initially, telephone systems were completely manual requiring an information agent for all communication with the caller and for determining the response to the inquiry based on some type of hard-copy data base. The data base generally consists of local street and route maps, schedules and timetables, daily bulletins on service interruptions, street closures and special services, notes and memos used as memory aids, and other such

information. While manual telephone systems are still in widespread use, their labour intensive nature makes them extremely costly to operate. The high operating cost usually restricts the size of the system and the hours of operation. Manual systems are, therefore, typically capacity constrained as opposed to demand responsive. With demand far in excess of capacity, callers suffer long delays or are unable to obtain information. Restricted service hours may result in the absence of any information late at night and on weekends. A further shortcoming of manual systems is that the information may be inadequate simply because manual systems are not capable of providing very detailed information in a timely manner. This can range from stop-specific schedule information to complex itinerary planning and travel time estimation.

Increased awareness of the importance of effective public transit marketing for improved customer satisfaction and increased ridership has resulted in efforts to improve telephone information systems. Advances in computer technology in the 1960s and 1970s further raised the potential for automating a number of the functions previously performed manually by information agents. Certain aspects of the information service lend themselves well to computer applications since a very large percentage of caller inquiries can be grouped into four distinct call types - itinerary, schedule, route and fare - which makes programming a computer a relatively manageable task.

Efforts to automate telephone information systems have followed quite different paths in the U.S. and Canada. U.S. efforts initially focused on computerized information storage and retrieval within the traditional telephone information system environment. In Canada, the first efforts to computerize transit information focused on one specific type of request, namely, transit schedule information, and developed fully automated schedule information systems to provide callers with stop-specific scheduled arrival times, without the need for an information agent.

In the early 1970s, research carried out in several locations in the U.S. pointed to potential cost effective applications of computer technology to data retrieval functions. Research undertaken at the National Bureau of Standards (NBS) and at the MITRE Corporation investigated the costs and benefits of automated data retrieval. Work on route-finding algorithms conducted at the System Development Corporation (SDC) in Santa Monica, California, culminated in the development of the Passenger Routing Information System (PARIS), a proprietary system which was successfully demonstrated by the Santa Monica transit system in 1974. Encouraged by the earlier work and supported by federal funding, the Southern California Rapid Transit District (SCRTD) and the Washington Metropolitan Area Transit Authority (WMATA) pursued the development of automated transit information system (ATIS) technology in the form of computer-assisted telephone information systems.

Canadian interest in automating passenger information for public transit emerged in 1975 in response to a concept of automated bus information proposed by Mr. C.B. Lewis, Director of the Urban Transportation Research Branch of Transport Canada. A project to develop and evaluate an automatic bus passenger information system was undertaken by Transport Canada and Mississauga Transit between 1975 and 1979. The objective of the project was to increase the attractiveness of transit, and hence, increase ridership, by making stop-specific bus arrival time information readily available to any prospective transit user. It was believed that such information would greatly reduce waiting time at bus stops, the most important deterrant to using transit, particularly when waiting times are lengthy, uncertain, or occur in poor weather or at night.

The Mississauga demonstration developed a computer communications system to monitor the location and status of buses, predict arrival times of buses at any stop, and respond to incoming calls with an automatically composed voice message. By 1979, the fully automated system was operating on six bus routes in Mississauga. Conceptually the Automatic Bus Passenger Information (ABPI) system was very simple. Small, on-board

micro processors monitored the bus's progress by counting wheel revolutions. This information was transmitted to the central computer via mobile radios. The computer then used detailed route information (i.e., distances, average speeds, and stop locations) to determine each vehicle's location and estimate its arrival time at subsequent stops along the route. A voice response system enabled the computer to automatically compose a voice message from a pre-recorded digitized voice track to respond to incoming calls. Because the last four digits of the telephone number identified the bus route and stop number queried, the act of calling the computerized system was itself a request for specific information. Thus, there was no need for the caller to communicate with the computer. The telephone equipment transmitted the last four digits dialed to the computer which responded with an actuated voice giving the estimated arrival time of the next two buses at the requested stop.

The Mississauga demonstration marked the beginning of a concerted effort in Canada to improve the effectiveness of public transit telephone information services. In the late 1970s, Teleride Corporation was founded to develop and market computer communications systems for transportation. Their "Telerider" system, fashioned after the Mississauga ABPI system, is a computerized telephone information system that automatically gives schedule and other information to transit riders. Telerider is now an integral part of the transit programs in many Canadian and American cities.

Other communication systems marketed by Teleride include, "Teledriver", an automatic vehicle location and control system, and "Televiewer", a colour graphic videotex computer system that provides transit information at high traffic locations such as shopping malls and office buildings. Both systems may be operated as stand alone systems or integrated with Telerider to provide stop-specific arrival time information in real time. The Televiewer system is available via overhead display units, similar to those installed at airports, or as an interactive system in which riders query the system directly.

"Intellimap" is Teleride's newly developed interactive computer system that can provide trip planning information to riders at high density traffic locations. Each unit consists of a large electronically sensed map and a liquid crystal display. By touching any one of many possible locations on the map, a user can determine how best to arrive at that location.

Recently two transit properties - Metro Transit of Halifax-Dartmouth and CTCRO (Commission de transport de la Communaute regionale de l'Outaouais) in Hull - implemented computerized dispatching and user information systems. The two systems are similar, each incorporating an automatic vehicle monitoring, location and control system, an automatic passenger counting system, and, an automated passenger information system which provides stop-specific bus arrival time information in real time. The automated telephone information component works much the same as the original Mississauga ABPI system. A central computer monitors the status and location of all buses in the system and computes expected arrival times at bus stops. A caller dials a pre-designated exchange followed by a four digit stop number. The system responds with a computerized voice message informing the caller of the arrival times of the first and subsequent bus for each route which serves the requested stop. In addition, messages concerning service disruptions, reroutings, delays, etc. may be added to the standard message. The Hull system utilizes pre-recorded words to compose the message while the Halifax-Dartmouth system uses a machine synthesized voice, which enables the dispatcher to program an almost unlimited number of words and phrases.

The Halifax-Dartmouth passenger information system provides arrival time information via other media as well. Potential transit users can obtain information from public display terminals at major shopping centers, bus terminals and the Dartmouth Ferry Terminal. At other high-traffic locations, where a public display terminal is not feasible, push-button actuated weatherproof speakers have been installed. Finally, the system provides a suitable interface to members of the travelling public who are deaf through a special telephone number which can communicate the

information to a teletype machine. In all cases, the information provided is real time, based on the actual bus position as opposed to its scheduled position.

An innovative approach to providing transportation information appeared at the world exposition in Vancouver in 1986. The integrated transportation information system (ITIS) developed by Oracle Communications Inc. of Burnaby, B.C., is an automated, multi-media information system which provides schedule, routing, fare and other service information for ferry, transit, airline, traffic, parking, and inter-city bus and rail systems serving the greater Vancouver area. The system may be accessed by touch-tone telephone, special interactive terminals located at Sky Train stations, or through home computers. The information is presented by a computer generated voice message for telephone inquiries, graphically on display terminals, or by printed copy for home computer users. During EXPO 86, ITIS information on traffic and EXPO parking was also available on radio.

The heart of Oracle's ITIS system is the host computer which stores up-to-date information about the schedules, routes, fares and other service characteristics for the various modes, handles the inquiries and gives an answer, either as a "picture" or a computer synthesized voice message. Users interact with the system by selecting choices from menus and inputing information as requested by the computer. The public transit component of the system is based on schedule information and provides users with stop-specific scheduled arrival times, directions about how to get to a specific destination by transit, a description of the service offered on a specific route, and general information about fares, customer service, hours of operation and use of the transit system. Users accessing the system by touch-tone telephone make menu selections by over-dialing numbers on the telephone keypad.

The automated telephone information system in use in Hamburg, Germany is a fully automated operation with a user-machine dialogue utilizing synthetic voice generation. The Automatische Fahrplan Information (AFI) system has been operating on a demonstration basis since 1979. Expansion of the system to provide full access for the total service population is being planned. The automated transit information system consists of three main components: a central computer which stores all schedule data and computes the best connection based on trip request inputs; five automated auxiliary machines which provide hard-copy printouts of the trip information after users input the trip destination; and the telephone interface system which includes the speech generation component. Users communicate with the AFI system either via the keyboard on the automated auxiliary machines or by telephone in the local call area. The major element of the computer software is the route search routine, which is designed to select the optimum route for the user from the large number of possible connections between given origin and destination points.

Operation of the telephone system requires the user to first identify the code numbers for his origin and destination station or stop in an address directory. Upon accessing the system, the user starts his dialogue by dialing code numbers on his telephone in response to verbal system prompts. The caller overdials the code numbers for departure station, destination station, the weekday, the desired time, and designation of the desired time as a departure or arrival. If the caller makes an error, dialing 99 allows him to start the sequence again without losing the connection. The number of digits to be dialed is fourteen plus the telephone number to access the system. The AFI system can be accessed by both touch tone and dial telephones, although the latter require special technical provisions by the telephone company.

1.5 Report Organization

Chapter 2 examines the experience of two large U.S. transit properties with automated data storage and retrieval within the traditional telephone

information system environment. The Washington Metropolitan Transit Authority and the Southern California Rapid Transit District implemented computer assisted telephone information systems in the late 1970s.

Chapter 3 is devoted to an evaluation of Teleride's automated schedule information system. Trends in transit ridership are examined to identify ridership increases attributable to the automated stop-specific schedule information system. Telerider usage is analyzed to evaluate the public's acceptance of the system and the degree to which the system is utilized at various times during the day, week and year. Where possible, the call volumes are compared with costs to assess cost effectiveness of the information system.

The report concludes with a discussion of the major findings of the study.

2. Computer Assisted Telephone Information Systems

2.1 Introduction

In the early 1970s the Urban Mass Transportation Administration (UMTA) in the United States implemented a research and development program to determine the feasibility of applying state-of-the-art computer technology to the provision of transit information. The objective of the Automated Transit Information Systems (ATIS) program was the innovative introduction of automation to telephone information services to assist information agents, increase system productivity and reduce costs, and improve the service offered to the travelling public.

The basic rationale behind the ATIS program was that telephone information system efficiency could be improved through computerization of the data storage and retrieval functions. Certain aspects of these functions lend themselves well to computer applications. First, caller requests are highly repetitive and most can be grouped into four distinct types: schedule, itinerary, route and fare requests. The limited number of call types simplifies software requirements for data retrieval.

Second, the personalized nature of information requested by callers requires a thorough knowledge of the service area geography and transit system characteristics. This information (i.e., street addresses, local landmarks, bus routes, etc.) can be digitized on a coordinate grid system and stored in computer memory for easy access.

Third, information agents are often called upon to optimize certain trip parameters for the caller (such as total travel time, number of transfers, or walking distance). A computer can be programmed to replicate agent comparison/optimization logic and quickly evaluate alternative routings.

Fourth, it is important that the information supplied be accurate and consistent across agents. Computer programming logic ensures that the

same query will always elicit the same response. Finally, high public demand for transit information requires agents to work as quickly and efficiently as possible in retrieving data. The high-speed calculating capabilities of a computer are thus particularly appropriate in this application. In addition, a computer can provide a more thorough investigation of alternative responses than time limitations permit using traditional manual retrieval methods.

In the mid 1970s, UMTA funded two major demonstration projects focusing on the deployment of ATIS technology in public transit telephone information services. The two properties selected for the demonstrations were the Southern California Rapid Transit District (SCRTD) and the Washington Metropolitan Area Transit Authority (WMATA). The basic objective of the two demonstrations was to make telephone information systems more efficient through automation of data storage and retrieval functions, traditionally performed manually by information agents. The two projects were very similar in terms of system concept and design. The SCRTD decision to limit the demonstration to only part of their service area (the San Fernando Valley) made their task somewhat simpler than WMATA's where full system-wide implementation was undertaken. Given the similarity of the two projects, only the Washington experience is discussed in detail.

2.2 WMATA Automated Information Directory System

For a number of reasons, the Washington Metropolitan Area Transit Authority was a prime candidate for application of ATIS technology. WMATA's complex, multi-modal transit system covered an area of 1500 square miles and 16 separate political jurisdictions, extending from the District of Columbia into the Virginia and Maryland suburbs. The authority operated buses on over 800 routes in 200 separate transit corridors, as well as an expanding rapid rail system. WMATA's telephone information facility received five to ten thousand calls daily on fifty different trunk lines. The 57 agents and seven supervisory personnel answered calls in three shifts, eighteen hours a day, 365 days a year. Despite this considerable investment

in manpower, between 30 and 40 percent of all incoming calls were "lost" during peak demand periods. (A "lost" call represents a caller placed on hold by the telephone equipment because all agents are busy and who subsequently hangs up before reaching an agent).

Although the origins of the Automated Information Directory System can be traced to the early 1970s, system implementation did not begin officially until 1978. Software development and data entry were finished in late 1980 and system acceptance and testing was complete by February 1981. The total development and implementation cost for the system was $1,635,000 comprised of a $675,000 Federal capital grant (1974), a $435,000 Federal research and development grant (1976), $250,000 for office design changes and HVAC equipment (1978), and $275,000 for data base development (1978-1980).

The computerized system incorporates two distinct data bases - a geographic data base and a transit system data base. System software draws upon these two data bases to provide information on schedules, itineraries, routes and fares. Creation of the geographic data base involved digitizing all street addresses in the WMATA service area as well as over 1,000 landmarks often referenced by callers in requesting transit information. In order to obtain resolution down to the individual street address, it was necessary to construct an extremely detailed grid system, with individual elements approximately 25 feet on a side. This resulted in well over 50,000,000 elements in the entire service area.

Data elements required to describe the operating characteristics of the transit system included transit stops and routes, bus and rail operating schedules, and fares and fare zones. The task of developing a computer directory of all bus stops and assigning them to the appropriate route or routes proved to be very labour-intensive and time consuming. Each bus stop was assigned an address to reference the geographic data base and clearly assigned to each route it served. The problem of how to standardize the poorly formatted scheduling department data was overcome by

purchasing new word processing equipment and developing a standardized format, using time reference points that were logical from an operational point of view.

An impact assessment of the Automated Information Directory System was undertaken using a "before-and-after" methodology. Quantitative data included statistics on caller and information section performance recorded by the automatic call distribution system, performance data collected by monitoring the agents at their work stations, and summaries of all computer transactions as recorded on the daily log file. Qualitative data were gathered through opinion surveys and interviews with WMATA management, supervisory personnel and information agents.

Analysis of the data led to conflicting conclusions regarding system influences on operator productivity. Agents were evenly divided on the post-implementation questionnaire regarding the system's influence on call counts, while data from the telephone answering equipment revealed a decrease overall in the information section's productivity following system implementation. In contrast, agents were almost unanimous in the opinion that the computerized system made their jobs easier, and routine performance tests revealed that agents were capable of answering calls at the rate of 30 to 40 per hour, a 30 percent increase over their normal manual speed.

The conflicting results were attributed to the system configuration and agents' use of the computer for requests which were more easily answered from hard copy material. Call monitoring indicated that schedule inquiries were still handled fastest manually. Since schedule inquiries made up about one-quarter of all incoming calls, agents who used the computer for nearly every call were actually less productive than those who used it more selectively. High agent turnover during system implementation was also a contributing factor to the productivity decline since newer agents tended to rely more on computer or manual references than their more experienced counterparts. Experienced agents were capable of answering

the majority of calls from memory and tended to use the computer only for calls requiring construction of long or complex itineraries.

For the average agent, it was felt that a 50-50 balance between computer and manual data retrieval was the most productive. At the time of evaluation, agents were using the computer for 25 to 30 percent of all calls. Further productivity improvements were expected as agents became more familiar with the system and increased their usage, especially for itinerary type calls which constitute approximately two-thirds of the calls received.

Increased consistency and response accuracy with the new system was acknowledged by almost all individuals. Agents indicated by an overwhelming margin that computer responses were at least as accurate and had a greater level of detail than responses retrieved manually. The built-in error reporting function not only resulted in greater accuracy of the data base and a more workable system, but also led to increased confidence on the part of the agents that they were personally responsible for system accuracy.

The anticipated benefit of training time reduction for new operators was one objective not achieved with the automated system. Initially, the six-week training period was shortened to a two-week course which included computer practice, communications skills development, and some rudimentary background in the use of manual references. It was soon discovered, however, that without the more extensive geographic and transit system knowledge, new agents were unable to provide details to callers concerning landmarks to use as reference points during their trips. Moreover, they were unable to make interpretive judgements between the four alternative itinerary responses routinely produced. Their reliance on the computer for simple fare and schedule requests, better handled manually or from memory, also limited productivity. In light of these deficiencies, the original six-week training period was reinstated.

The decision to retain the hard-copy reference data as a backup to the computerized system meant that anticipated cost savings due to centralized data base updating were not achieved. The creation and maintenance of computerized geographic and transit system data bases did, however, provide benefits to other departments within WMATA as well as to other agencies in the Washington area. Data base updates are made so frequently that the geographic data base is becoming recognized as the most accurate address directory available for the D.C. metropolitan area. Other departments within WMATA that make use of the computerized transit system data base include the scheduling, planning and bus stop departments.

Thus, the implementation of the Automated Information Directory System, with its computerized data bases, created a significant resource which has strong potential for serving a number of users aside from information agents and callers. System costs must, therefore, be viewed in terms of overall system benefits, not just the productivity increases and cost savings within the WMATA Office of Marketing. In addition to the monetary gain to WMATA resulting from a 10 - 15 percent increase in agent productivity, other less tangible benefits included increased accuracy and consistency of information provided and enhanced agent job satisfaction. Further spinoff benefits have been realized by the use of the unified data bases as a resource for other WMATA departments and local government agencies.

In the spring of 1983 WMATA's Office of Marketing participated in a telephone survey of callers to their telephone information service (TIS). Between March 29 and April 8, 1983, 602 questionnaires were completed from a representative random sample of 890 callers. The results of the survey give a clear picture of the system's users and the cost effectiveness of providing the service.

The survey indicated that the telephone information service generates considerable income for WMATA, clearly above the Authority's costs to operate the service. Eighty-two percent of the callers reported making the

transit trip for which they had requested information. Of these callers, two-thirds indicated that they would not have taken the transit trip without the information provided by the telephone service.

Based on average fares, it was estimated that the revenue generated exclusively by these "TIS-prompted" rides was approximately $858 per 1,000 calls answered by the information section. At an estimated cost-of-operations of $620 per 1,000 calls, the TIS contributes $238 in net revenue for every 1,000 calls handled by the section. Based on 1982 call volumes (2,190,000), it was estimated that the TIS contributed $521,220 to the Authority's net revenue. These figures include only the trips by callers who would otherwise not have made a transit trip, and do not include any subsequent trips made as a result of the informaton provided in the initial call to the telephone service. It is likely, therefore, that the additional revenue estimates are somewhat understated. The results indicate that WMATA's telephone service is a cost-effective means of providing the public with transit system information.

2.3 SCRTD Computerized Customer Information System

The Telephone Information Section of the Customer Relations Department at the Southern California Rapid Transit District (SCRTD) is one of the largest telephone transit marketing centers in the United States. Its 85 information agents answer queries in three shifts, 24-hours a day. On an average day, between 10,000 and 13,000 calls are received, with agents answering over 800 calls per hour during peak demand periods. Even with this level of effort, over 30 percent of all incoming calls are "lost" during peak demand periods, that is, callers put on hold by the telephone answering equipment who subsequently hang up before reaching an agent.

This situation typifies the SCRTD prior to the introduction of the Computerized Customer Information System (CCIS). A pilot implementation covering the 300-square mile San Fernando Valley region north of downtown Los Angeles was initiated in the spring of 1977 with a $150,000 capital grant from UMTA. Legal difficulties with the original request for proposals

delayed the award of the contract until May 1978. System implementation involved the creation of a geographic data base and the establishment of a transit data base for the San Fernando Valley. The technical foundation of the CCIS also required conversion of the PARIS programs for application to the SCRTD's mainframe computer. Hardware and other system improvements cost the SCRTD an additional $50,000.

By March 1979, the system was considered sufficiently developed to begin training some regular agents in the work force. Initially 32 volunteer agents received a short 8-hour training session from the contractor. By June 1980, the balance of the agents had been trained by SCRTD staff.

The SCRTD officially accepted the CCIS on June 4, 1979 in accordance with the terms of the contract. Operational deployment of the CCIS in the SCRTD Telephone Information Center consisted of seven regular agent work positions equipped with CRT terminal units, with an additional unit used for system updating. The first year of CCIS operation was actually a continuation of the system implementation "shakedown" period in which agent experiences with CCIS call processing resulted in identification of numerous areas where further improvements were required. By February 22, 1981, the CCIS was considered ready for an official evaluation of system operation and performance.

A large amount of quantitative and qualitative data were collected over the 90-day steady-state evaluation period. A careful review of the data led to generally positive findings concerning the overall performance of the CCIS in its pilot demonstration. An evaluation of the system influences on agent productivity reached basically the same conclusions as those found at WMATA: under controlled experimental conditions, the more experienced CCIS agents were appreciably faster than their manual and mixed mode counterparts; however, under normal operating conditions, their productivity was no geater than that of agents relying on manual data retrieval (i.e., 20 calls per hour). It was concluded that the computerized system did indeed enable experienced agents to approach the higher rate of 30 calls per hour;

however, the mental stress experienced by an agent working at this pace was too great to be sustained for extended periods. Nevertheless, a prime advantage of the CCIS over manual retrieval is that all calls, even those involving the most complex itineraries, are of relatively uniform length, allowing the CCIS agent to develop a steady working pace. The implication was that the CCIS raised the potential, which as yet had not been achieved, for increases in overall Information Section productivity.

Agent responses to the "before" and "after" opinion surveys concerning system response accuracy demonstrated a decided shift towards acceptance of CCIS responses. In the "before" survey, only 40 percent of the agents felt CCIS accuracy was better than manual retrieval while 77 percent of the agents responded affirmatively to the same question in the "after" survey.

In the area of agent training, Information Section management indicated this was perhaps the greatest positive impact exerted by the CCIS on the Section's operations. The need for agent memorization of geographical and route data was drastically reduced by computerized information storage and retrieval. This enabled the 8-week standard agent training period to be cut by at least half. This period could be even shorter for trainees already possessing typing skills. The reduced training time has strong potential for benefits in the areas of improved personnel recruitment and retention. The work force from which agents are recruited can be greatly expanded to include older and part-time employees, neither of which was suited for the rigors of the previous agent training course. Statistics showed that older employees were generally more dependable, and inclusion of part-time employees would allow management more flexibility than it presently enjoyed in the scheduling of full-time agent vacations and other benefits. The long term implications of these training benefits were seen as significant cost savings.

Another potential major improvement in Information Section operations resulting from CCIS implementation was the capability to perform reference data base updating functions on a centralized basis. One

full-time employee at a single terminal could perform data base updating tasks which previously occupied 15 supervisors almost full-time. This would free the supervisors to perform the functions for which their jobs were originally created: troubleshooting and solving system problems on the floor as they occur.

Finally, the impact of CCIS on agent job satisfaction was found to be generally positive. In the "after" survey, 74 percent of the agents rated their job satisfaction as excellent or good, compared to 67 percent in the "before" survey. In the "before" survey, 52 percent of the agents described CCIS influence on their job satisfaction as "positive", 44 percent responded "no influence", and only four percent responded "negative". By contrast, 84 percent of the responses to the same question in the "after" survey indicated "positive" influence, while only 16 percent indicated "no influence", and there were no "negative" responses. In addition, 75 percent of the manual agents responding to the "after" survey felt that learning to use CCIS would increase their job satisfaction, while 25 percent felt that it would decrease job satisfaction.

2.4 Effectiveness of Computer Assisted Systems

Both WMATA and SCRTD are satisfied with the operation of their computer assisted telephone information systems. Both follow-up studies concluded that the benefits of computerized storage and retrieval of information more than offset the development and operating costs of the systems. A telephone survey of callers to WMATA's information service, conducted in the spring of 1983, was able to demonstrate a net contribution of $521,220 to the Authority's annual revenue. This was based on an estimated cost-of-operations of $620 per 1000 calls and an additional $858 per 1000 calls in revenue generated by "TIS-prompted" rides.

Increased consistency and greater response accuracy was acknowledged by almost all individuals associated with the new systems. The general concensus among information agents was that the computerized system enhanced job satisfaction. In the area of agent productivity, initial

experience at both transit authorities was inconclusive; however, productivity increases in the range of ten to fifteen percent were achieved as agents became more familar with the computerized systems. The creation and maintenance of computerized geographic and transit system data bases to support the new system also benefited other departments within the transit authority and agencies in the surrounding areas.

The one area where conflicing results were achieved concerns training time reductions. The SCRTD halved their standard training period following implementation of the computerized system and considered this as perhaps the greatest positive impact of the new system because it also improved personnel recruitment and retention. They were able to recruit older and part-time employees, neither of which was suited for the rigors of the previous eight-week agent training course. Older employees were generally found to be more dependable, and the inclusion of part-time employees allowed management more flexibility in the scheduling of personnel. The long-term implications of these training benefits is seen as a significant cost savings for the SCRTD.

WMATA initially reduced the six-week training period to a two-week course but soon discovered that new agents lacked the extensive geographic and transit system knowledge needed to assist callers and correctly interpret the computer's responses. Their reliance on the computer for simple fare and schedule requests, better handled manually or from memory, also limited their productivity. In light of the defiencies, the original six-week training period was reinstated.

The two approaches to agent training requirements are more a reflection of the different service area characteristics and operating philosophies than any significant differences in the operation of the two computerized systems. The Washington system was installed system-wide and therefore encompasses a much larger area than the pilot implementation in the San Fernando Valley area at the SCRTD. The Washington transit system also serves a significant number of visitors to the

area who require more detailed information on boarding locations, transfer points and alighting stops referenced more to easily identifiable landmarks than street addresses. Viewed in this light, the two approaches can be seen to satisfy the basic operating philosophy of the individual transit property. The SCRTD was willing to sacrifice some productivity in new agents for improved personnel recruitment and retention, and greater flexibility in the scheduling of personnel. WMATA, on the other hand, placed greater emphasis on the agent's knowledge of the area and the transit system, and was satisfied with retaining the original extended training period.

In summary, the computer assisted telephone information systems achieved their desired objectives and have proven to be a cost effective means of providing transit users with telephone information. The systems are most applicable to large transit authorities with complex multi-modal systems. It is doubtful whether the computerized system can be justified strictly on a cost basis when compared to the traditional manual information system, but WMATA and the SCRTD are satisfied that the overall benefits of a computerized information storage and retrieval system outweigh the additional costs incurred.

3. Automated Schedule Information Systems

3.1 Introduction

Canadian efforts to improve public transit telephone information services followed a somewhat different path than in the United States. In Canada, the initial focus was on one specific type of information request, namely, transit schedule information, and efforts were directed toward the development of a fully automated schedule information system.

The Automatic Bus Passenger Information (ABPI) project carried out at Mississauga Transit in the late 1970s was the first Canadian application of computer technology to transit telephone information services. The project was initiated in 1975 with the basic objective of increasing the attractiveness of public transit by making information on the arrival time of buses at the nearest stop readily available to any prospective transit rider. It was believed that this would greatly reduce waiting time at bus stops, particularly when such waiting becomes lengthy, uncertain, or takes place in poor weather or at night. Waiting time is considered to be one of the major deterrents to transit riding.

A computer communications system was developed and installed in Mississauga in late 1977. The system was designed to automatically provide callers with stop-specific bus arrival times in real time (i.e., based on the bus's actual position rather than its scheduled position). A device to count wheel revolutions was connected to an on-board micro-processor interfaced to a mobile radio in the bus. A dual minicomputer installation was programmed to monitor the status of buses and predict arrival times at any stop. A voice response system was attached to the central computer which enabled the computer to respond to incoming calls with an automatically composed voice message. The fully automatic system was introduced in February 1978 and coverage was extended to six of Mississauga's 20 bus routes. The system, marketed under the name "ERICA" or "Easy Rider", enabled transit patrons to obtain estimates of the arrival time of buses at their nearest stop by means of a 20-second telephone call. To use the

service, an individual dialed an ordinary seven-digit number, the first three digits of which accessed the Easy Rider service, the next two digits indicated the route, and the last two digits identified the bus stop.

The Mississauga demonstration was the forerunner of the current automated schedule information systems now in widespread use in Canada and the U.S. The major supplier of automated schedule information systems is Teleride Corporation, a Canadian company founded in the late 1970s to develop and market computer communications systems for transportation. The following section provides a brief description of the Teleride system and presents the history of its development. Section 3.3 analyzes the impact of automated schedule information systems on transit operations in Canada and the U.S.

3.2 Telerider Schedule Information System

The "Telerider" schedule information system is a computerized telephone information system, developed and marketed by Teleride Corporation, that automatically provides schedule and other service information to transit patrons. Although the system was fashioned after the Mississauga ABPI system, arrival time information is reported from the master schedule and not from the estimated bus location. The Telerider system can be converted to a real time system by linking it with Teleride's "Teledriver" automatic vehicle location and control system. At present this has not been done, although Hamilton Street Railway is studying implementation of a real time Telerider-Teledriver system.

The history of Telerider installations in Canada and the U.S. is summarized in Exhibit 1. The first Telerider system was installed at OC Transpo in Ottawa in the fall of 1980. Initially the system was installed in one-third of the service area on a demonstration basis. Expansion to the full OC Transpo system was completed by September 1981. In 1982, the ABPI system in Mississauga was replaced by system-wide Telerider due to

Exhibit 1

History of Telerider Installations

Transit Authority	Telerider Implementation	Comments
OC Transpo, Ottawa	Sept. 1980	· one-third of the service area · system-wide expansion 1981
COTA, Columbus, Ohio	Oct. 1981	· test basis on 3 routes · system-wide in 1983
Mississauga Transit	Feb. 1982	· replaced ABPI system
Kitchener Transit	Feb. 1982	· one central system serving Kitchener-Waterloo, Brantford and Guelph
Brantford Transit	March 1982	
Guelph Transit	June 1982	
TTC, Toronto	1982-1985	· demonstration on 11 routes in Etobicoke · system-wide in 1987
Salt Lake City, Utah	Feb. 1983	· test basis on 6 routes · going system-wide in 1987
Hamilton Street Railway	Aug. 1985	· test basis on eight routes
PAT, Pittsburg, Pennsylvania	Aug. 1985	· test basis on 30% of routes
Winnipeg Transit	Jan. 1986	· system-wide implementation

difficulties with the on-board micro processors which relayed bus status and location to the central computer. The centralized Telerider system serving Kitchener-Waterloo, Brantford and Guelph was installed at Kitchener Transit in 1982. Also in 1982, the Toronto Transit Commission undertook a three-year Telerider demonstration on eleven routes in southern Etobicoke. The TTC is planning system-wide Telerider implementation in 1987. The Hamilton Street Railway initiated a Telerider demonstration on eight routes in August 1985. In January 1986, Winnipeg Transit implemented Telerider system-wide. Other Canadian cities considering implementation of Teleride's automated schedule information system include Montreal, Calgary, Oakville and Windsor.

In the U.S. Teleride has systems operating in Columbus, Ohio, Salt Lake City, Utah and Pittsburg, Pennsylvania. Telerider has been operating system-wide in Columbus since 1983, while the Utah Transit Authority plans system-wide implementation in 1987. The Port Authority of Allegheny County is evaluating the Pittsburg demonstration before making a decision on system-wide implementation. An automated schedule information system similar to Telerider has recently been installed on eight routes in Albany, New York. The system was developed by Ken Roberts and Associates.

Telerider has undergone numerous software and hardware updates since its introduction in the late 1970s. Initially, the computer utilized a pre-recorded digitized voice track to compose the audio response to incoming calls. In some of the early installations the actuated voice was found to be choppy and difficult to understand, however, software enhancements have improved the voice quality to the point where it now closely replicates human speech. The main drawback to the use of a digitized voice track is the limited vocabulary and additional time and cost constraints associated with recording new words and phrases as need arises. The limited vocabulary is most restrictive in the provision of service information concerning delays, reroutings and special services. Some transit authorities, notably Kitchener and Mississauga, are switching to computer

synthesized voice response using the "Dectalk" system which gives almost unlimited flexibility in the composition of schedule and service messages.

The Telerider system is designed to facilitate system customization by the transit authority to meet their specific needs. The basic message includes an initial greeting (e.g., "Hello"), confirmation of the stop number dialed, route name and number, scheduled arrival time for the next two or three buses, and a message termination (e.g., "Thank you, Goodbye" or "Thank You for Calling Telerider, Goodbye"). The initial greeting and message termination are selected by the transit authority and pre-recorded on the voice track. Software parameters may be set to control the other message elements. Generally the arrival time is given in minutes from the present time if it is within 60 minutes and in clock time for arrival times greater than 60 minutes. This has been found to minimize possible confusion about the correct time. Other parameters control message length, safety margin in reporting arrival times and inclusion of other service messages. Messages can be automatically shortened when there is heavy demand on the system by dropping the initial greeting, third arrival time, message termination and any status messages. Most transit properties incorporate a safety margin in reporting arrival times to reduce the possibility of missing a bus if it is slightly ahead of schedule. This interval, generally set at two or three minutes, is subtracted from all actual scheduled arrival times in the message heard by the public.

The Telerider system allows status messages to be appended to the standard message whenever there are significant changes from the normal operating schedule. Delay information, either route-specific or system-wide, may be inserted to inform callers of the amount of delay and the reason for the delay. This is usually done by selections from pre-designated categories (i.e., short delays on Routes 10 and 12 due to traffic congestion; long delays on all routes due to weather conditions). Callers can also be advised of detours or diversions and given an alternative telephone number for additional information. The range of other service messages is limited only by the pre-recorded vocabulary stored on the digitized voice track.

Synthetic voice generation, on the other hand, gives the user an almost unlimited vocabulary with which to compose messages.

The Telerider system also offers flexibility in data base updating and report preparation. Reports can be produced to summarize the utilization of telephone trunk lines and call holding times due to "busy" telephone numbers to monitor system capacity. Calls by route or area and time period can be used to assess system utilization and ridership impacts. Scheduler and incident logs provide valuable data on the schedule reliability of the bus routes and overall transit system performance.

3.3 Impact of Telerider on Ridership and Revenue

Teleride markets its Telerider system on the basis of improving the transit authority's information dissemination and stimulating demand for their services by making public transit more attractive through reduced waiting time at bus stops. The increased demand translates into increased revenue for the authority which is claimed to more than offset the capital and operating costs of Telerider. An automated schedule information system also offers a transit authority other potential benefits. Because the system is fully automated and focuses on only one specific information request, it can provide the information faster and at a more detailed level than by manual means. This not only provides a better service to those requesting schedule information, but frees up the traditional telephone information service to answer the more complex routing and itinerary planning requests.

Generally, the increase in ridership expected from the installation of an automated schedule information system is in the order of three percent. With this level of ridership impact, it is virtually impossible to isolate the effect of Telerider from the host of other factors which influence transit usage. Factors such as changes in population and employment can have a great impact on transit usage. Even weather conditions can influence ridership, especially for discretionary travel which is a major market segment for the automated systems in attracting users to the transit system.

Impact measurement is further hindered by the difficulties experienced in accurately estimating ridership and Telerider calls, particularly on a route specific basis. Most transit authorities do periodic farebox revenue counts to monitor ridership on a route-specific basis. Monthly pass riders are not captured in the farebox counts and therefore must be estimated separately. Generally an annual ridership survey is conducted and the percentage of pass users derived from the survey is applied to farebox revenue counts to estimate total revenue passengers until the next survey.

For a number of reasons, problems in correlating Telerider usage with ridership also arise when estimating the number of calls on a specific route. First, individuals may make more than one call to the system for the same trip, especially on low frequency routes with long headways. This inflates the number of Telerider users and makes it appear that more riders use the service than is the case. Second, stop numbers assigned to specific bus stops, or groups of stops, are generally not route-specific. If more than one route uses the same bus stop, calls cannot be accurately assigned to the specific routes. Call assignment ranges from assigning all calls to the most heavily travelled route, to proportioning calls based on ridership on the various overlapping routes. Although the second option is preferable, neither option accurately portrays Telerider utilization on a route-specific basis.

Acknowledging the above difficulties in assessing the impact of an automated schedule information system on transit usage, particularly on a route-specific basis, it is nonetheless instructive to look at the system-wide impacts of Telerider. Before proceeding to a detailed investigation of operational Telerider systems, a general understanding of the operating characteristics of Canadian transit authorities is needed. Exhibit 2 presents a summary of recent performance at a number of Canadian transit authorities. The Toronto Transit Commission (TTC) and the Commission de transport de la Communauté urbaine de Montreal (CTCUM) are Canada's largest public transit properties, providing service to urban areas of roughly

Exhibit 2

Operating Characteristics of Canadian Transit Authorities

Operating Characteristics	Yr.	Toronto Transit Commission	Montreal CTCUM	Calgary Transit	Winnipeg Transit	Ottawa-Carleton Reg Transit
Service Area Population	'80	2,113,438	1,973,000	561,000	578,000	486,600
	'81	2,137,395	1,973,000	591,857	578,000	493,000
	'82	2,137,395	1,884,442	623,133	566,000	499,500
	'83	2,137,395	1,884,442	620,692	568,000	506,000
	'84	2,137,395	1,884,442	617,918	585,000	508,000
	'85	2,138,000	1,884,442	625,000	578,924	538,071
Revenue Veh-Kms.	'80	162,142,164	139,488,000	24,995,000	26,098,000	38,022,000
	'81	172,742,875	148,127,703	27,264,000	25,921,000	39,410,921
	'82	181,578,896	139,742,127	29,499,921	25,955,447	39,766,566
	'83	182,046,779	140,638,615	21,650,700	26,451,045	40,556,083
	'84	183,731,529	139,152,578	23,842,791	26,754,957	42,357,368
	'85	185,919,000	148,820,509	30,160,813	26,223,743	39,886,009
Revenue Pass.	'80	366,424,000	314,122,696	52,422,000	60,416,000	74,208,000
	'81	392,040,000	335,875,736	55,200,000	59,597,000	78,884,183
	'82	401,150,000	299,566,000	53,807,821	59,279,721	83,457,058
	'83	405,746,000	311,953,564	46,131,645	59,032,867	85,422,946
	'84	418,132,000	349,727,819	46,000,000	59,357,203	87,175,000
	'85	432,160,000	372,058,681	48,640,000	58,116,160	85,014,101
Revenue per Passenger	'80	0.47	0.40	0.42	0.28	0.40
	'81	0.53	0.45	0.54	0.36	0.45
	'82	0.58	0.50	0.65	0.41	0.51
	'83	0.62	0.55	0.74	0.43	0.55
	'84	0.62	0.45	0.76	0.46	0.56
	'85	0.64	0.48	0.63	0.51	0.63
Cost per Passenger	'80	0.63	0.86	0.78	0.62	0.66
	'81	0.72	0.99	0.97	0.70	0.77
	'82	0.83	1.19	1.30	0.82	0.85
	'83	0.88	1.22	1.44	0.90	0.90
	'84	0.92	1.13	1.38	0.96	0.99
	'85	0.97	1.05	1.25	1.05	1.09
Revenue/Cost Ratio	'80	0.75	0.46	0.54	0.45	0.60
	'81	0.74	0.46	0.56	0.51	0.59
	'82	0.70	0.41	0.50	0.50	0.60
	'83	0.70	0.45	0.52	0.48	0.61
	'84	0.70	0.44	0.56	0.50	0.58
	'85	0.69	0.47	0.60	0.49	0.59
Ridership per Capita	'80	173.38	159.21	93.44	104.53	152.50
	'81	183.42	170.24	93.27	103.11	160.01
	'82	187.68	158.97	86.35	104.73	167.08
	'83	189.83	165.54	74.32	103.93	168.82
	'84	195.63	185.59	74.44	101.47	171.60
	'85	202.13	197.44	77.82	100.39	158.00
Rev. Pass. / Rev. Km.	'80	2.26	2.25	2.10	2.31	1.95
	'81	2.27	2.27	2.02	2.30	2.00
	'82	2.21	2.14	1.82	2.28	2.10
	'83	2.23	2.22	2.13	2.23	2.11
	'84	2.28	2.51	1.93	2.22	2.06
	'85	2.32	2.50	1.81	2.22	2.13

Exhibit 2 (Cont'd)

Operating Characteristics of Canadian Transit Authorities

Operating Characteristics	Yr.	Sudbury Transit	Brantford Transit	Guelph Transportat'n Commission	Oakville Transit	Kingston Transit
Service Area Population	'80	92,000	77,000	73,000	70,000	65,000
	'81	-	79,465	73,200	73,000	65,000
	'82	-	81,841	76,658	76,720	66,000
	'83	102,000	80,816	77,000	76,700	66,000
	'84	102,000	80,694	77,000	77,000	66,000
	'85	104,000	72,925	80,000	83,000	61,269
Revenue Veh-Kms	'80	3,211,000	1,617,000	1,263,000	1,453,000	1,434,000
	'81	-	1,672,673	1,265,499	1,428,000	1,506,563
	'82	3,150,000	1,633,987	1,357,342	1,208,000	1,481,381
	'83	2,766,576	1,645,749	1,435,805	1,292,000	1,460,968
	'84	2,569,113	1,564,050	1,476,881	1,494,000	1,395,301
	'85	2,213,801	1,563,025	1,487,130	1,608,986	1,535,924
Revenue Pass.	'80	3,992,000	2,323,000	3,457,000	1,978,000	2,879,000
	'81	-	2,305,420	3,461,486	2,262,000	2,746,066
	'82	4,672,812	2,330,834	3,665,000	2,238,000	2,998,418
	'83	5,287,205	2,153,369	3,811,290	2,243,000	3,163,921
	'84	4,958,174	2,028,314	4,284,781	1,896,000	3,242,334
	'85	4,091,282	1,980,215	4,065,679	2,281,203	3,177,843
Revenue per Passenger	'80	0.49	0.36	0.47	0.39	0.38
	'81	-	0.43	0.52	0.41	0.45
	'82	0.55	0.47	0.45	0.54	0.53
	'83	0.57	0.57	0.56	0.54	0.55
	'84	0.59	0.62	0.44	0.72	0.54
	'85	0.62	0.65	0.49	0.61	0.59
Cost per Passenger	'80	1.12	0.79	0.54	0.85	0.71
	'81	-	0.92	0.65	0.88	0.88
	'82	1.15	1.05	0.58	1.03	0.93
	'83	1.08	1.22	0.71	1.10	0.95
	'84	1.13	1.40	0.61	1.39	0.97
	'85	1.23	1.62	0.69	1.27	1.09
Revenue/Cost Ratio	'80	0.44	0.46	0.87	0.47	0.54
	'81	-	0.47	0.79	0.46	0.51
	'82	0.48	0.45	0.77	0.52	0.57
	'83	0.53	0.47	0.79	0.49	0.57
	'84	0.53	0.46	0.73	0.53	0.57
	'85	0.51	0.42	0.72	0.49	0.57
Ridership per Capita	'80	43.39	30.17	47.36	28.26	44.29
	'81	-	29.01	47.29	30.99	42.25
	'82	-	28.48	47.81	29.17	45.43
	'83	51.84	26.65	49.50	29.24	47.94
	'84	48.61	25.14	55.65	24.62	49.13
	'85	39.34	27.15	50.82	27.48	51.87
Rev. Pass. / Rev. Km.	'80	1.24	1.44	2.74	1.36	2.01
	'81	-	1.38	2.74	1.58	1.82
	'82	1.48	1.43	2.70	1.85	2.02
	'83	1.91	1.31	2.65	1.74	2.17
	'84	1.93	1.30	2.90	1.27	2.32
	'85	1.85	1.27	2.73	1.42	2.07

Exhibit 2 (Cont'd)

Operating Characteristics of Canadian Transit Authorities

Operating Characteristics	Yr.	Hamilton Street Railway	Mississauga Transit	London Transit Commission	Halifax-Dartmouth Transit	Kitchener Transit
Service Area Population	'80	460,000	290,000	258,000	144,000	193,000
	'81	460,000	305,307	266,000	277,727	193,900
	'82	460,000	313,000	270,000	277,800	198,850
	'83	414,000	337,170	268,000	214,364	201,838
	'84	414,000	349,810	275,000	214,364	204,500
	'85	386,277	349,000	275,000	214,364	210,724
Revenue Veh-Kms	'80	15,978,270	7,568,000	8,885,911	4,826,000	4,739,000
	'81	16,015,350	8,642,780	9,090,000	5,031,500	5,096,908
	'82	12,009,885	8,298,138	9,765,000	6,288,371	4,893,628
	'83	14,561,737	8,829,892	9,836,300	6,347,870	4,406,957
	'84	14,604,521	8,371,653	10,171,300	6,712,612	4,779,501
	'85	13,413,829	8,387,017	10,427,500	7,088,038	5,067,143
Revenue Pass.	'80	28,659,000	10,579,000	15,781,000	9,835,000	8,290,000
	'81	28,384,539	11,992,561	18,668,000	10,852,554	8,413,404
	'82	21,819,070	12,405,332	19,808,000	13,437,889	8,964,721
	'83	25,675,845	12,898,520	19,417,700	13,807,072	8,956,604
	'84	25,945,214	13,545,196	19,815,800	14,392,698	9,395,998
	'85	29,323,297	12,607,468	19,243,600	15,119,185	9,695,813
Revenue per Passenger	'80	0.42	0.52	0.44	0.48	0.42
	'81	0.48	0.55	0.47	0.53	0.58
	'82	0.55	0.68	0.53	0.61	0.49
	'83	0.60	0.70	0.59	0.62	0.54
	'84	0.64	0.74	0.60	0.63	0.57
	'85	0.72	0.77	0.66	0.64	0.60
Cost per Passenger	'80	0.82	0.96	0.63	0.72	0.94
	'81	0.97	0.98	0.66	0.96	0.99
	'82	1.15	1.13	0.75	0.95	1.07
	'83	1.28	1.21	0.83	0.98	1.13
	'84	1.37	1.26	0.84	1.04	1.13
	'85	1.28	1.46	0.96	1.08	1.22
Revenue/Cost Ratio	'80	0.50	0.54	0.70	0.67	0.44
	'81	0.50	0.56	0.71	0.55	0.59
	'82	0.48	0.60	0.71	0.64	0.46
	'83	0.46	0.58	0.71	0.63	0.48
	'84	0.48	0.60	0.73	0.62	0.52
	'85	0.58	0.54	0.71	0.61	0.50
Ridership per Capita	'80	62.30	36.48	61.17	68.30	42.95
	'81	61.71	39.28	70.18	39.08	43.39
	'82	47.43	39.63	73.36	48.37	45.08
	'83	62.02	38.26	72.45	64.41	44.38
	'84	62.67	38.72	72.06	67.14	45.95
	'85	75.91	36.12	69.98	70.53	46.01
Rev. Pass. / Rev. Km.	'80	1.79	1.40	1.78	2.04	1.75
	'81	1.77	1.39	2.05	2.16	1.65
	'82	1.82	1.49	2.03	2.14	1.83
	'83	1.76	1.46	1.97	2.18	2.03
	'84	1.78	1.62	1.95	2.14	1.97
	'85	2.19	1.50	1.85	2.13	1.91

two million people. The three transit authorities - Calgary Transit, Winnipeg Transit and Ottawa-Carleton Regional Transit - with service area populations between 500,000 and 1,000,000 are representative of large transit properties providing predominantly surface bus transportation. (Calgary has a light rail system providing service to the downtown area.) The five medium-sized transit properties, serving a population of between 200,000 and 500,000, include the Hamilton Street Railway Company, Mississauga Transit, the London Transit Commission, the Halifax-Dartmouth Metro Transit Commission and Kitchener Transit. The smaller transit authorities, serving areas with less than 100,000 population, include Sudbury Transit, Brantford Transit, the Guelph Transportation Commission, Oakville Transit and Kingston Transit.

The data presented in Exhibit 2 highlight the wide variation in operating philosophies at the various transit authorities. Focusing on the four groups of transit authorities, differentiated largely by service area population, the following trends are observable. The operating cost per revenue passenger carried generally increases as the size of the service area population and transit system decreases. The largest properties, serving Toronto and Montreal, had operating costs in the range of $1.00 per revenue passenger in 1985, while operating costs for the small properties, serving areas of less than 100,000 population, averaged $1.18 in 1985. The one major exception in the latter group is the Guelph Transportation Commission which has consistently shown extremely low operating costs per passenger. This can be partially explained by the level of service provided relative to the population served. In 1985, Guelph provided 18.6 revenue vehicle-kilometres of service per capita. This contrasts sharply with service levels provided at other transit authorities - 21.4 at Brantford, 24 at Kitchener, 45 at Winnipeg and 87 revenue vehicle-kilometres per capita at the Toronto Transit Commission.

Annual ridership per capita and revenue passengers per revenue vehicle-kilometre generally decline as the transit system and service area population decreases. In 1985, the Toronto Transit Commission had the

highest per capita ridership at 202, and Oakville Transit, the lowest at 27.5 rides per capita. Revenue passengers per revenue kilometre fluctuate more widely across transit authorities, reflecting the different operating policies and service area characteristics at the various transit authorities.

In these comparisons, the Guelph Transportation Commission has consistently deviated from the "norm". It generates the least revenue per passenger, incurs the lowest cost per passenger, exhibits the highest revenue/cost ratio and attains the highest revenue passengers per revenue vehicle kilometre. It would appear that their policy is to provide service only when and where it is heavily used. This minimizes costs and enables them to charge low fares while still maintaining a high revenue/cost ratio. One can hardly argue with the economics of such a policy, and the relatively high per capita ridership indicates that the area is well served by the transit system.

It is more difficult to identify consistent annual trends in the data presented. Both revenue per passenger and cost per passenger have increased significantly over the five years 1980-1985; however, there is no consistent trend in revenue cost ratios across the different properties. The two largest transit authorities have shown consistent growth in per capita ridership whereas the other properties have had little, if any, growth in per capita ridership, and in some cases it has declined.

The transit authorities with operational Telerider systems include Winnipeg (1986), Ottawa-Carleton (1981), Hamilton (1985), Mississauga (1982), Kitchener (1982), Brantford (1982) and Guelph (1982). Analysis of the impact of Telerider focuses on the experience of four transit properties - Winnipeg Transit, Mississauga Transit, Kitchener Transit and the Guelph Transportation Commission. Trends in ridership and Telerider usage were analyzed in assessing the impact of automated schedule information systems on transit patronage. In addition, Telerider operating costs were compared to system usage to estimate the cost per call at the various operating authorities.

3.3.1 Winnipeg Transit

Winnipeg Transit is a large transit authority, providing service to a population of just under 600,000 on 54 surface bus routes. The current fleet of 535 diesel buses provides approximately 26 million vehicle-kilometres of service and carries roughly 60 million revenue passengers annually. On January 22, 1986 Winnipeg implemented Telerider system-wide. The Teleride system marketed under the name "Telebus" is capable of handling 20,000 calls per day. Approximately 1900 telephone numbers are allocated to the 4200 bus stops within the city, with a maximum of three routes per number. The total cost of the project was approximately $1.3 million with costs shared equally between the City and the Provincial Government under the Urban Transit Capital Grants Program.

Exhibit 3 summarizes service and ridership for the period January through October for 1985 and 1986. Comparing data for the first ten months of 1986 with the corresponding period in 1985, the following points are noteworthy:

- change in the service provided was minimal. There was a 0.4% drop in bus -kilometres and a 0.8% drop in bus-hours in 1986.
- 4.4% increase in revenue passengers. In the first ten months of 1986 ridership increased 2,140,702 over 1985 levels.
- 3.3% increase in total revenue. Total system revenue increased $768,882 in 1986.
- In terms of average daily revenue passengers, weekday ridership increased 4.6%, Saturday ridership dropped by 0.4% and Sunday ridership increased 7.4%.

On a system-wide basis it appears that the introduction of the automated schedule information system may have had a positive impact on ridership. The new transit fares, introduced on March 1, 1986 also appear to have influenced transit usage. Senior citizen ticket prices increased by 20%, from 25¢ to 30¢ per ticket, while cash fares increased from 30¢ to 35¢. Other ticket prices remained at the 1985 levels, but the adult cash fare increased from 80¢ to 85¢. Monthly bus passes increased $1.00 to $28.00 for adults and $14.00 for seniors, children and high school students. During 1986

Exhibit 3

Winnipeg Transit Service and Ridership Summary

Month	Bus Kilometres (Millions)			Revenue Passengers (Millions)			Total Revenue (Millions)		
	1985	1986	% Cge	1985	1986	% Cge	1985	1986	% Cge
Jan.	2.289	2.289	0.0%	5.361	5.407	0.9%	2.403	2.559	6.5%
Feb.	2.083	2.082	0.0%	4.935	5.031	1.9%	2.300	2.439	6.0%
Mar.	2.260	2.198	-2.7%	5.238	5.422	3.5%	2.594	2.629	1.3%
Apr.	2.133	2.177	2.1%	5.076	5.532	9.0%	2.375	2.501	5.3%
May	2.202	2.150	-2.4%	4.982	5.195	4.3%	2.287	2.356	3.0%
Jun.	2.083	2.086	0.1%	4.714	5.066	7.5%	2.162	2.229	3.1%
Jul.	2.171	2.145	-1.2%	3.878	3.978	2.6%	2.053	2.063	0.5%
Aug.	2.137	2.060	-3.6%	3.910	4.047	3.5%	2.036	2.064	1.4%
Sep.	2.106	2.174	3.2%	4.970	5.348	7.6%	2.434	2.532	4.0%
Oct.	2.254	2.259	0.2%	5.256	5.435	3.4%	2.641	2.683	1.6%
January - October Tot'l	21.717	21.620	-0.4%	48.321	50.462	4.4%	23.286	24.055	3.3%

Month	Average Daily Revenue Passengers (Thousands)								
	Weekday			Saturday			Sunday		
	1985	1986	% Cge	1985	1986	% Cge	1985	1986	% Cge
Jan.	219.6	221.1	0.7%	87.9	92.8	5.6%	35.8	34.4	-4.0%
Feb.	220.1	223.7	1.6%	93.0	100.6	8.2%	40.2	38.8	-3.7%
Mar.	215.1	232.4	8.0%	101.0	98.5	-2.5%	43.1	47.1	9.1%
Apr.	213.6	226.7	6.1%	98.9	92.3	-6.7%	38.9	43.8	12.6%
May	202.5	216.4	6.9%	87.8	88.4	0.7%	35.1	41.7	18.8%
Jun.	201.5	212.8	5.6%	95.5	88.8	-6.9%	41.5	48.3	16.5%
Jul.	154.5	158.6	2.7%	73.5	73.7	0.2%	37.0	38.7	4.6%
Aug.	160.2	171.2	6.9%	74.6	82.8	11.0%	34.5	34.8	0.9%
Sep.	218.6	228.2	4.4%	91.8	87.3	-4.9%	38.4	41.3	7.8%
Oct.	214.4	222.5	3.8%	91.9	87.5	-4.8%	34.5	38.1	10.3%
January - October Avg.	202.0	211.4	4.6%	89.6	89.3	-0.4%	37.9	40.7	7.4%

there was also a significant shift in monthly pass usage. For the period January through October, reduced pass (i.e., children, high school students and seniors) sales increased 28.1%, while there was a 4.2% drop in adult pass sales.

To investigate ridership trends further, two routes were selected for analysis. Route 12 is a crosstown route serving predominantly lower middle income neighbourhoods. Peak period headways are 16 minutes with off-peak and Saturday service every 30 minutes. There is no weekday late evening or Sunday service on this route. Route 24 is a downtown route serving middle and high income areas. Weekday and Saturday daytime express service to and from the downtown area is also provided on this route. Headways range from 5 to 10 minute service during the AM and PM peak periods to 15 to 30 minute service in the off-peak periods, and 60 minute headways on Sundays.

Service and ridership for the two routes are summarized in Exhibits 4 and 5. Average daily revenue-kilometres and revenue passengers since January, 1984 are shown for weekday, Saturday, and, Sunday and holiday service. Focusing on the period January through October, service has basically remained constant over the two year period. Average weekday ridership declined in 1985 and increased in 1986. On route 12 the 1.7% decline in weekday ridership in 1985 was more than offset by the 3.6% increase in 1986, resulting in a 1.8% increase in average weekday ridership over the two-year period. The 3.2% drop in revenue passengers on route 24 in 1985 was not completely offset by ridership increases in 1986, resulting in a 0.6% decline in average weekday ridership in 1986 as compared to 1984 levels. Saturday ridership on route 12 shows a consistent decline in transit usage - a 9.2% drop in 1985 and a 10.5% drop in 1986, for a combined two-year decline in Saturday ridership of almost 19%. Route 24, on the other hand, posted a 1.1% increase in Saturday ridership for the first ten months of 1986 after a 5.8% decline over the same period in 1985. Over the two-year period, however, average Saturday ridership on route 24 declined by 4.8%.

Exhibit 4

Winnipeg Transit Operating Statistics - Route 12 : William

Weekday Service and Ridership

Month	Revenue Kilometre			Percent Change			Revenue Passenger			Percent Change		
	1984	1985	1986	84-85	85-86	84-86	1984	1985	1986	84-85	85-86	84-86
Jan	1459	1515	1513	3.8%	-0.1%	3.7%	3560	3273	3277	-8.1%	0.1%	-7.9%
Feb	1504	1515	1513	0.7%	-0.1%	0.6%	3651	3349	3274	-8.3%	-2.2%	-10.3%
Mar	1502	1515	1513	0.9%	-0.1%	0.7%	3357	2990	3531	-10.9%	18.1%	5.2%
Apr	1533	1515	1556	-1.2%	2.7%	1.5%	3215	3221	3474	0.2%	7.9%	8.1%
May	1546	1556	1539	0.6%	-1.1%	-0.5%	3264	3159	3343	-3.2%	5.8%	2.4%
Jun	1529	1545	1530	1.0%	-1.0%	0.1%	3060	2969	3132	-3.0%	5.5%	2.4%
Jul	1488	1558	1427	4.7%	-8.4%	-4.1%	2349	2421	2153	3.1%	-11.1%	-8.3%
Aug	1483	1541	1438	3.9%	-6.7%	-3.0%	2349	2460	2642	4.7%	7.4%	12.5%
Sep	1489	1558	1535	4.6%	-1.5%	3.1%	3046	3349	3335	9.9%	-0.4%	9.5%
Oct	1499	1553	1537	3.6%	-1.0%	2.5%	3108	3245	3370	4.4%	3.9%	8.4%
Nov	1517	1632		7.6%			3200	3364		5.1%		
Dec	1506	1514		0.5%			3362	3470		3.2%		
January - October Avg	1503	1537	1510	2.3%	-1.8%	0.5%	3096	3044	3153	-1.7%	3.6%	1.8%

Saturday Service and Ridership

Month	Revenue Kilometre			Percent Change			Revenue Passenger			Percent Change		
	1984	1985	1986	84-85	85-86	84-86	1984	1985	1986	84-85	85-86	84-86
Jan	520	521	521	0.2%	0.0%	0.2%	1010	766	772	-24.2%	0.8%	-23.6%
Feb	521	521	521	0.0%	0.0%	0.0%	945	772	723	-18.3%	-6.3%	-23.5%
Mar	521	521	589	0.0%	13.1%	13.1%	904	866	651	-4.2%	-24.8%	-28.0%
Apr	521	521	521	0.0%	0.0%	0.0%	929	882	677	-5.1%	-23.2%	-27.1%
May	521	521	521	0.0%	0.0%	0.0%	893	874	654	-2.1%	-25.2%	-26.8%
Jun	521	520	519	-0.2%	-0.2%	-0.4%	892	858	691	-3.8%	-19.5%	-22.5%
Jul	521	521	514	0.0%	-1.3%	-1.3%	733	618	537	-15.7%	-13.1%	-26.7%
Aug	521	512	567	-1.7%	10.7%	8.8%	686	759	701	10.6%	-7.6%	2.2%
Sep	521	521	514	0.0%	-1.3%	-1.3%	825	692	739	-16.1%	6.8%	-10.4%
Oct	521	523	514	0.4%	-1.7%	-1.3%	797	735	859	-7.8%	16.9%	7.8%
Nov	521	625		20.0%			840	796		-5.2%		
Dec	521	521		0.0%			988	833		-15.7%		
January - October Avg	521	520	530	-0.1%	1.9%	1.8%	861	782	700	-9.2%	-10.5%	-18.7%

Exhibit 5

Winnipeg Transit Operating Statistics - Route 24 : Ness

Weekday Service and Ridership

Month	Revenue Kilometre			Percent Change			Revenue Passenger			Percent Change		
	1984	1985	1986	84-85	85-86	84-86	1984	1985	1986	84-85	85-86	84-86
Jan	2990	3052	3036	2.1%	-0.5%	1.5%	8262	8113	7777	-1.8%	-4.1%	-5.9%
Feb	3048	3052	3048	0.1%	-0.1%	0.0%	8725	7633	7923	-12.5%	3.8%	-9.2%
Mar	3041	3052	3053	0.4%	0.0%	0.4%	7560	7480	8001	-1.1%	7.0%	5.8%
Apr	3058	3052	3053	-0.2%	0.0%	-0.2%	7655	7654	8042	.0%	5.1%	5.1%
May	3066	3056	3024	-0.3%	-1.0%	-1.4%	7563	7552	7721	-0.1%	2.2%	2.1%
Jun	3074	3049	3035	-0.8%	-0.5%	-1.3%	7782	7581	8013	-2.6%	5.7%	3.0%
Jul	3042	3033	3011	-0.3%	-0.7%	-1.0%	6445	5792	6098	-10.1%	5.3%	-5.4%
Aug	3057	3029	3022	-0.9%	-0.2%	-1.1%	6479	5986	6705	-7.6%	12.0%	3.5%
Sep	3049	3055	3060	0.2%	0.2%	0.4%	8368	8358	8122	-0.1%	-2.8%	-2.9%
Oct	3060	3059	3055	0.0%	-0.1%	-0.2%	7902	8102	7852	2.5%	-3.1%	-0.6%
Nov	3055	3191		4.5%			7670	8807		14.8%		
Dec	3026	3020		-0.2%			8506	8529		0.3%		
January - October												
Avg	3049	3049	3040	0.0%	-0.3%	-0.3%	7674	7425	7625	-3.2%	2.7%	-0.6%

Saturday Service and Ridership

Month	Revenue Kilometre			Percent Change			Revenue Passenger			Percent Change		
	1984	1985	1986	84-85	85-86	84-86	1984	1985	1986	84-85	85-86	84-86
Jan	1743	1737	1738	-0.3%	0.1%	-0.3%	3509	3244	3214	-7.6%	-0.9%	-8.4%
Feb	1738	1737	1750	-0.1%	0.7%	0.7%	3456	3380	3402	-2.2%	0.7%	-1.6%
Mar	1744	1737	1738	-0.4%	0.1%	-0.3%	3743	3745	3250	0.1%	-13.2%	-13.2%
Apr	1738	1737	1738	-0.1%	0.1%	0.0%	3780	3782	3432	0.1%	-9.3%	-9.2%
May	1738	1744	1748	0.3%	0.2%	0.6%	3568	2890	3454	-19.0%	19.5%	-3.2%
Jun	1744	1738	1737	-0.3%	-0.1%	-0.4%	3436	3320	3188	-3.4%	-4.0%	-7.2%
Jul	1738	1750	1738	0.7%	-0.7%	0.0%	2555	2564	2716	0.4%	5.9%	6.3%
Aug	1733	1743	1738	0.6%	-0.3%	0.3%	2860	2679	2897	-6.3%	8.1%	1.3%
Sep	1700	1737	1738	2.2%	0.1%	2.2%	3426	3154	3564	-7.9%	13.0%	4.0%
Oct	1738	1797	1738	3.4%	-3.3%	0.0%	3607	3201	3182	-11.3%	-0.6%	-11.8%
Nov	1730	2090		20.8%			3527	3664		3.9%		
Dec	1747	1664		-4.8%			3934	4130		5.0%		
January - October												
Avg	1735	1746	1740	0.6%	-0.3%	0.3%	3394	3196	3230	-5.8%	1.1%	-4.8%

Exhibit 5 (Cont'd)

Winnipeg Transit Operating Statistics - Route 24 : Ness

Sunday and Holiday Service and Ridership

Month	Revenue Kilometre			Percent Change			Revenue Passenger			Percent Change		
	1984	1985	1986	84-85	85-86	84-86	1984	1985	1986	84-85	85-86	84-86
Jan	641	645	641	0.6%	-0.6%	0.0%	611	513	602	-16.0%	17.3%	-1.5%
Feb	641	645	640	0.6%	-0.8%	-0.2%	685	563	528	-17.8%	-6.2%	-22.9%
Mar	641	645	641	0.6%	-0.6%	0.0%	621	654	665	5.3%	1.7%	7.1%
Apr	642	645	641	0.5%	-0.6%	-0.2%	677	551	649	-18.6%	17.8%	-4.1%
May	641	639	641	-0.3%	0.3%	0.0%	563	604	669	7.3%	10.8%	18.8%
Jun	660	656	641	-0.6%	-2.3%	-2.9%	546	1056	727	93.4%	-31.2%	33.2%
Jul	641	641	642	0.0%	0.2%	0.2%	543	625	1081	15.1%	73.0%	99.1%
Aug	578	641	641	10.9%	0.0%	10.9%	489	463	588	-5.3%	27.0%	20.2%
Sep	667	642	641	-3.7%	-0.2%	-3.9%	618	747	526	20.9%	-29.6%	-14.9%
Oct	641	641	641	0.0%	0.0%	0.0%	577	556	568	-3.6%	2.2%	-1.6%
Nov	641	649		1.2%			627	472		-24.7%		
Dec	644	651		1.1%			524	600		14.5%		
January - October Avg	639	644	641	0.7%	-0.5%	0.3%	593	633	660	6.8%	4.3%	11.3%

Sunday and holiday ridership on route 24 exhibits greater variability than either weekday or Saturday ridership. This is partly due to the small ridership on these days and the inclusion of holiday ridership which may deviate considerably from normal Sunday ridership. Averaging over the ten-month period, however, consistent ridership increases were attained in 1985 and 1986, resulting in an overall increase of 11.3% in average Sunday revenue passengers on route 24.

The above analysis of data from Winnipeg Transit cannot, at this level of detail, establish a direct impact on ridership from the introduction of the automated schedule information system. Comparing ridership in the first ten months of Telerider operations with that of the previous year shows an overall increase in revenue passengers of roughly five percent. Studying ridership trends on two specific routes over a somewhat longer period (January 1984 - October 1986) indicates that ridership has not changed materially over the two-year period. Combining the average weekday, Saturday and Sunday ridership to form an average weekly ridership on each route shows a 0.8% increase in revenue passengers on route 12 and a 0.8% decrease on route 24 over the two-year period 1984 to 1986. This would tend to suggest that Telerider has had little, if any, impact on ridership since its introduction in January, 1986. It is possible that the ridership declines experienced in 1985 would have continued through 1986, or that the increases in 1986 would have been smaller, had the automated schedule information system not been installed. This hypothesis is obviously not testable. Demographic and employment shifts in the Winnipeg area undoubtedly influenced transit ridership. However, detailed data in this area were not available for incorporation into the analysis.

To investigate Telerider usage, average daily calls and average daily system utilization, expressed as calls per 1000 revenue passengers, have been summarized in Exhibit 6. The cost effectiveness of the automated schedule information system can be assessed by comparing capital and operating costs with total calls to the system. System utilization (i.e., calls per 1000 passengers) reflects transit users' perceived benefits of the stop-

Exhibit 6

Winnipeg Transit Telerider Utilization

Month	Avg. Daily Calls			Avg. Daily Utilization (Calls/1000 Rev. Pass.)		
	Wkday	Sat	Sun	Wkday	Sat	Sun
Jan'86						
Feb						
Mar	14573	15060	9556	62.7	152.9	203.1
Apr	12369	13538	7580	54.6	146.7	173.0
May	9910	10475	6267	45.8	118.4	150.3
Jun	8831	8626	5614	41.5	97.1	116.2
Jul	7754	8173	4719	48.9	110.9	121.9
Aug	9074	8035	5175	53.0	97.1	148.9
Sep	11249	10991	6261	49.3	126.0	151.5
Oct	11420	12293	7321	51.3	140.4	192.3
Avg	10648	10899	6562	50.9	123.7	157.2

specific schedule information made available through Telerider. Before proceeding to a discussion of the information presented in Exhibit 6, a word of caution is necessary on the interpretation of the data. First, Telerider was introduced to the Winnipeg area in January and the first few months of operation are not characteristic of long term usage. On the one hand, system experimentation and familiarization undoubtedly led to the higher than average calling rates during March and April. On the other hand, calling rates can be expected to increase somewhat as more Winnipeg residents become aware of the new information system and its potential benefits. Second, the average derived from the March to October period are not representative of annual averages since the winter months, generally the period of highest usage, are not represented in the data.

Given the above comments, analysis of the Telerider call information is limited. The average daily calls to the system mirror the seasonal ridership pattern characteristic of most Canadian transit operations - that of declining usage in the spring, low usage over the summer months, and increasing usage in the fall. Focusing on average daily utilization, which controls for changes in ridership, lower system utilization during the summer months is still evident. This is understandable since the warmer weather makes waiting at bus stops less onerous and therefore the need to minimize waiting time is not as great as during the winter months. Average weekday Telerider utilization has remained relatively constant around 50 calls per 1000 revenue passengers. Saturday and Sunday utilization has been appreciably higher, averaging 125 and 157 calls per 1000 revenue passengers respectively. This emphasizes the need for schedule information when service is less frequent and travel behaviour is not as regimented.

No attempt was made to correlate capital and operating costs with system usage because of the limited data on both call volumes and operating costs. In addition, no analysis of system utilization on a route-specific basis was undertaken due to the assignment of all calls to the most heavily travelled route for stops serving more than one bus route. Since most routes have one or more overlapping sections, the Telerider call statistics do not portray system utilization accurately at the route-specific level.

3.3.2 Mississauga Transit

The City of Mississauga is one of the fastest growing urban areas in Canada, a fact reflected in the consistent growth in transit service and ridership. At present, Mississauga Transit provides service to an urban area of approximately 370,000 population with 36 surface bus routes and carries in excess of 14 million revenue passengers annually. Mississauga was the site of the original Automatic Bus Passenger Information demonstration. The ABPI system operated on six bus routes in Mississauga from 1979 until February, 1982 when Telerider was installed system-wide.

Annual service and ridership statistics for Mississauga Transit are presented in Exhibit 7. Labour disputes in the fall of 1984 and 1985 resulted in service cancellations - two weeks in 1984 and almost six weeks in 1985. To accurately portray annual service and ridership trends over the period 1976-1985, representative annual revenue vehicle-kilometres and revenue passengers were estimated for 1984 and 1985 as shown below:

Year	Vehicle-Kilometres	Revenue Passengers	Adjusted Veh.- Kms	Adjusted Rev. Pass.
1984	8,371,653	13,545,196	8,705,565	14,087,196
1985	8,387,017	12,607,468	9,419,265	14,193,468

Using the adjusted figures for 1985, it is possible to draw some conclusions concerning system-wide trends over the period 1976-1985. The population of the City of Mississauga has increased almost 50% over the nine-year period, which translates to an average annual growth rate of 4.3%. Over the same period, annual revenue passengers increased almost 60%, representing an average annual growth rate of 5.3%, while service (i.e., revenue vehicle-kilometres) increased 28% or 2.8% per annum. The annual ridership increases can be related to population growth through annual per capita ridership levels. Over the nine-year period, per capita ridership has increased from 35.6 to 38.7, an 8.7% increase. This is not unexpected in a rapidly developing urban area as growth in the transit system provides better access to the developing employment and recreational opportunities within the area.

Exhibit 7

Mississauga Transit Annual Ridership and Service Statistics

Year	Revenue Passengers	% Chge	Revenue Veh-Kms	% Chge	Rev Pass / Veh-Km	Miss. Pop'n	% Chge	Per Capita Ridership
1976	8,910,631		7,355,054		1.21	250,399		35.59
1977	9,307,222	4.45%	7,364,601	0.13%	1.26	263,652	5.29%	35.30
1978	9,982,239	7.25%	7,833,445	6.37%	1.27	273,467	3.72%	36.50
1979	10,467,572	4.86%	7,327,030	-6.46%	1.43	283,429	3.64%	36.93
1980	10,579,039	1.06%	7,568,326	3.29%	1.40	290,000	2.32%	36.48
1981	11,993,013	13.37%	8,642,780	14.20%	1.39	305,307	5.28%	39.28
1982	12,405,333	3.44%	8,298,138	-3.99%	1.49	313,000	2.52%	39.63
1983	12,898,520	3.98%	8,829,892	6.41%	1.46	337,170	7.72%	38.26
1984	13,545,196	9.22%	8,371,653	-1.41%	1.62	349,810	3.75%	40.27
1985	12,607,468	0.75%	8,387,017	8.20%	1.50	367,000	4.91%	38.67
1986	8,368,760							

Notes :
1. Transit strike Oct.22 - Nov.4, 1984.
2. Transit strike/lockout Sept.18 - Oct.27, 1985.
3. The percentage change in annual revenue passengers, revenue vehicle kilometres and per capita ridership for 1984 and 1985 has been adjusted to compensate for the days when no transit service was available.
4. 1986 Ridership is for January through July.

To investigate the system-wide impacts of Telerider, population and ridership growth in the period 1982 to 1985 was compared to the period 1977-1980. (1981 data were not incorporated in the analysis due to the uncharacteristically high growth in service and ridership) Annual ridership in the four-year period following introduction of the automated schedule information system increased 14.4% (using adjusted 1985 ridership) compared to the 13.7% increase experienced between 1977 and 1980. Population increased 17% in the post-implementation period, compared with a 10% growth in the pre-implementation period. In absolute terms, annual revenue passengers grew by 1.27 million and population increased 26,348 in the pre-Telerider period, while a ridership growth of 1.79 million and a population growth of 54,000 was observed in the post-Telerider period. The higher absolute growth in ridership during the post-Telerider period was more than offset by the larger population growth. This brief analysis of annual system-wide statistics does not demonstrate any significant growth in ridership which may be attributed to the Telerider system; in fact, there appears to be a levelling-off in the growth of annual per capita ridership.

To investigate ridership trends in greater detail, average weekday, Saturday and Sunday ridership has been summarized in Exhibit 8 for January through March and June through August for the years 1981 to 1986. The January-March period is characteristic of transit usage during the winter months and has traditionally been the period of highest Telerider usage. The summer months, June through August, generally exhibit lower ridership and Telerider utilization. To dampen the effects of random fluctuations in ridership and highlight annual trends, average ridership for the three-month periods are tabulated in Exhibit 9. Seasonal fluctuations in ridership are evident from the data presented in Exhibits 8 and 9. Average weekday ridership generally drops three to four percent in the summer months while Saturday ridership may drop by as much as seven percent. Sunday ridership, on the other hand, has consistently increased during the summer months with percentage increases ranging from 9 to 18% above January-March

EXHIBIT 8

MISSISSAUGA TRANSIT

AVERAGE DAILY RIDERSHIP

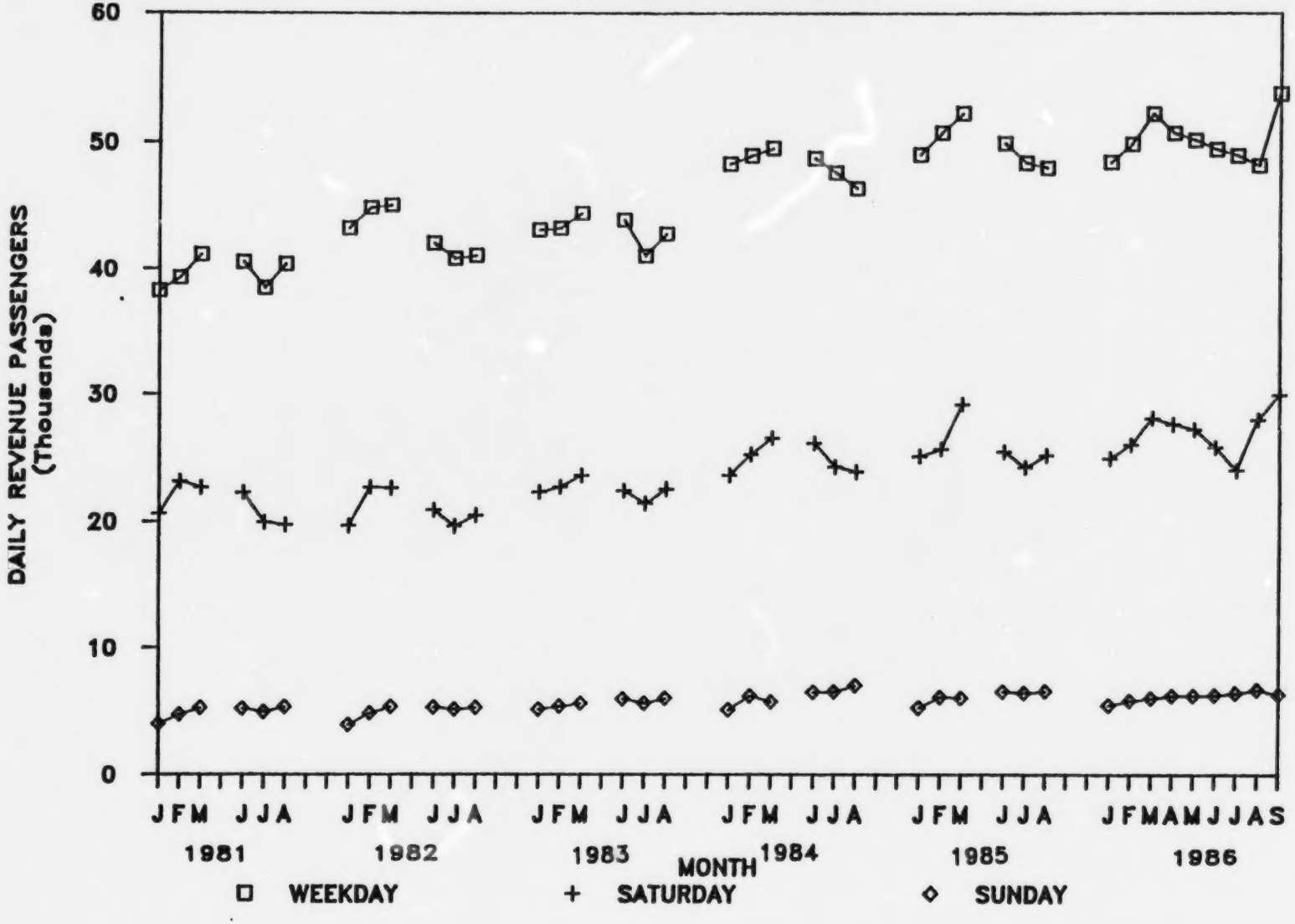


Exhibit 9

Mississauga Transit Average Daily Revenue Passengers : 1981 - 1986

January - March

Year	Average Daily Revenue Passengers						Weekly		%	%
	Wkday	% Cge	Sat.	% Cge	Sun.	% Cge	Average	% Cge	Sat.	Sun.
1981	39,550		22,143		4,660		224,554		9.9%	2.1%
1982	44,348	12.1%	21,639	-2.3%	4,681	0.5%	248,062	10.5%	8.7%	1.9%
1983	43,509	-1.9%	22,841	5.6%	5,356	14.4%	245,742	-0.9%	9.3%	2.2%
1984	48,917	12.4%	25,116	10.0%	5,677	6.0%	275,379	12.1%	9.1%	2.1%
1985	50,680	3.6%	26,623	6.0%	5,795	2.1%	285,819	3.8%	9.3%	2.0%
1986	50,148	-1.1%	26,321	-1.1%	5,779	-0.3%	282,840	-1.0%	9.3%	2.0%

June - August

Year	Average Daily Revenue Passengers						Weekly		%	%
	Wkday	% Cge	Sat.	% Cge	Sun.	% Cge	Average	% Cge	Sat.	Sun.
1981	39,779		20,650		5,155		224,700		9.2%	2.3%
1982	41,241	3.7%	20,344	-1.5%	5,235	1.6%	231,786	3.2%	8.8%	2.3%
1983	42,464	3.0%	22,091	8.6%	5,839	11.5%	240,252	3.7%	9.2%	2.4%
1984	47,584	12.1%	24,727	11.9%	6,692	14.6%	269,341	12.1%	9.2%	2.5%
1985	48,777	2.5%	24,930	0.8%	6,522	-2.6%	275,337	2.2%	9.1%	2.4%
1986	48,872	0.2%	25,920	4.0%	6,468	-0.8%	276,750	0.5%	9.4%	2.3%

levels. The percentage increases in Sunday ridership are high, primarily because of the low ridership levels on Sundays where small absolute increases appear as large percentage changes. In absolute terms, Sunday ridership is only about one-eighth of weekday ridership and one quarter of the ridership experienced on Saturdays.

Focusing on annual ridership trends, there is no consistent pattern of ridership growth that may be attributed to the introduction of the automated passenger information system. One of the benefits of the system claimed by Teleride is its ability to attract riders during off-peak periods and on weekends. The data do not show any appreciable change in Saturday or Sunday ridership relative to weekday ridership.

Exhibit 10 has been prepared to investigate Telerider usage. In terms of average daily calls to the system over the four-year period 1983-1986, winter weekday and Saturday calls have increased approximately 60%, while Sunday calls have increased 140%. Telerider usage during the summer months has shown slower growth, averaging 22% on weekdays, 32% on Saturdays and 78% on Sundays. Combining the average weekday, Saturday and Sunday call volumes, average weekly calls during the winter months have increased from 26,000 to 42,750, a 64% increase over the four-year period. Average weekly calls during the June to August summer period have increased 26%, from 25,800 in 1983 to 32,600 in 1986.

Telerider utilization, expressed as calls per 1000 revenue passengers, relates system usage to ridership. As illustrated in Exhibits 10 and 11, Telerider utilization has grown steadily over the four-year period 1983 to 1986. System utilization during the winter months, January through March, has increased 38% on weekdays, 40% on Saturdays and 124% on Sundays. Corresponding increases for the summer months are lower - 6% for weekdays, 12% for Saturdays and 60% for Sundays. The higher growth rate in Telerider utilization during the winter months has resulted in an average weekday utilization some 26% higher in the winter than in the summer. Average Saturday utilization is now roughly 36% higher during the winter,

Exhibit 10

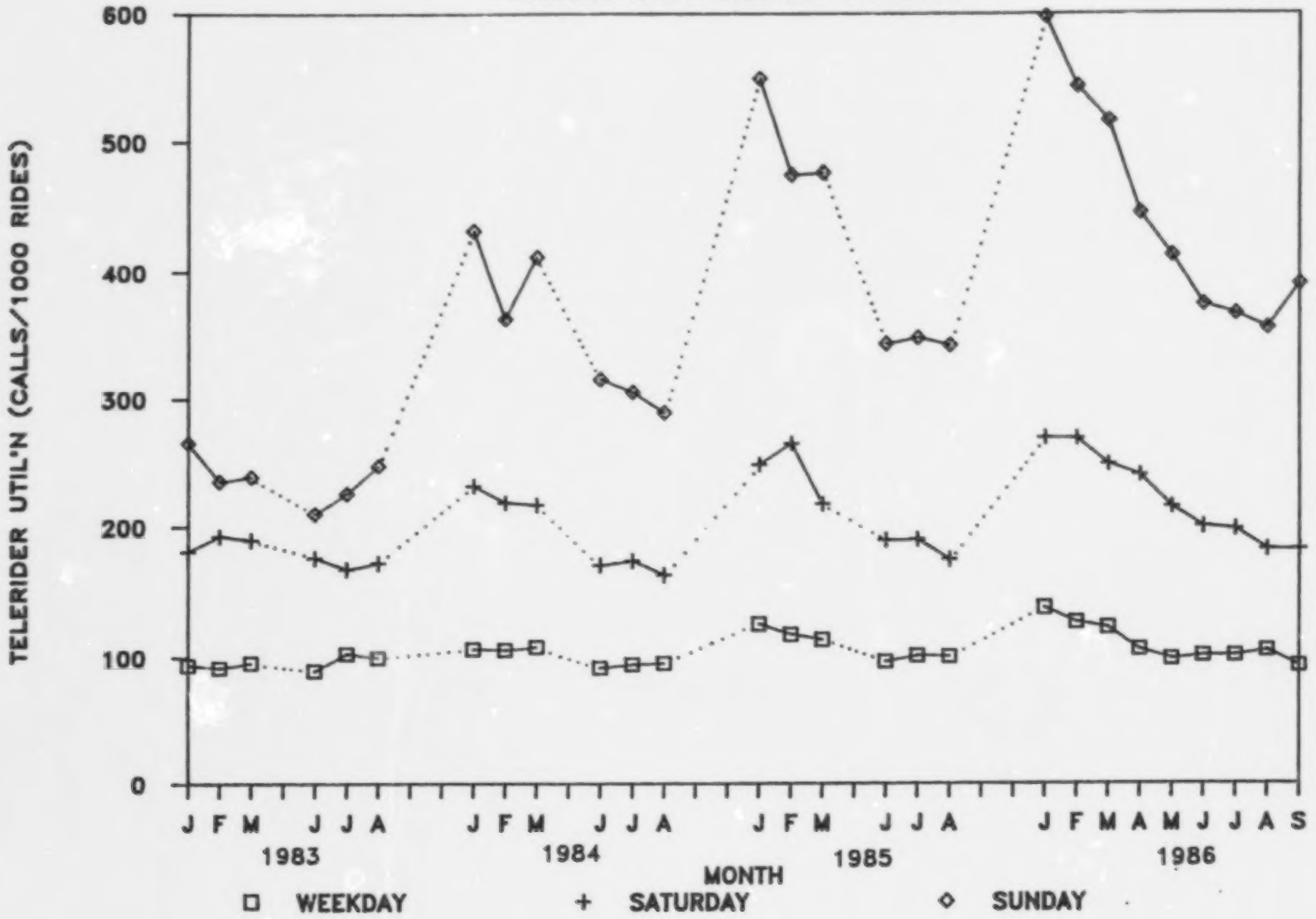
Mississauga Transit Telerider Usage

Yr/Mo	Average Ridership			Telerider Calls			Telerider Util'n		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun
Jan '83	43,010	22,274	5,115	4,027	4,044	1,358	94	182	265
Feb	43,160	22,678	5,370	3,957	4,381	1,263	92	193	235
Mar	44,357	23,570	5,584	4,242	4,480	1,335	96	190	239
Jun	43,771	22,371	5,938	3,916	3,954	1,246	89	177	210
Jul	40,931	21,395	5,579	4,221	3,600	1,260	103	168	226
Aug	42,691	22,508	6,000	4,257	3,889	1,484	100	173	247
Jan '84	48,314	23,610	5,083	5,160	5,476	2,196	107	232	432
Feb	48,929	25,230	6,218	5,198	5,520	2,257	106	219	363
Mar	49,508	26,509	5,731	5,369	5,754	2,361	108	217	412
Jun	48,736	26,099	6,493	4,468	4,466	2,049	92	171	316
Jul	47,623	24,222	6,555	4,488	4,229	2,002	94	175	305
Aug	46,394	23,861	7,029	4,421	3,912	2,032	95	164	289
Jan '85	49,052	25,069	5,249	6,194	6,230	2,880	126	249	549
Feb	50,755	25,640	6,093	6,010	6,791	2,890	118	265	474
Mar	52,234	29,159	6,042	5,966	6,346	2,876	114	218	476
Jun	49,917	25,426	6,555	4,832	4,831	2,250	97	190	343
Jul	48,400	24,206	6,431	4,911	4,619	2,237	101	191	348
Aug	48,014	25,159	6,579	4,832	4,418	2,252	101	176	342
Jan '86	48,430	24,900	5,462	6,741	6,715	3,262	139	270	597
Feb	49,843	25,995	5,838	6,389	7,003	3,169	128	269	543
Mar	52,171	28,067	6,037	6,469	6,993	3,113	124	249	516
Apr	50,708	27,621	6,233	5,412	6,645	2,777	107	241	446
May	50,156	27,206	6,250	4,968	5,875	2,580	99	216	413
Jun	49,458	25,770	6,255	5,039	5,181	2,341	102	201	374
Jul	48,964	24,003	6,449	4,984	4,772	2,366	102	199	367
Aug	48,195	27,986	6,701	5,098	5,134	2,383	106	183	356
Sep	53,736	29,948	6,316	5,014	5,489	2,465	93	183	390

EXHIBIT 11

MISSISSAUGA TRANSIT

AVERAGE DAILY TELERIDER UTILIZATION



while Sunday utilization increases 51% during the winter months. Focusing on the 1986 data, approximately 13% of the weekday riders use the Telerider schedule information system during the winter months, dropping to about 10% during the summer. Saturday utilization is roughly double the experience on weekdays, with 26% of the revenue passengers using the system during the winter and 19% during the summer. Sunday utilization is much higher, with more than 50% of the Sunday riders using the service during the winter and 37% using it during the summer. Actual Telerider utilization is probably overestimated by the above percentages as some transit users make more than one call to the system for the same ride, particularly during off-peak periods and on Saturdays and Sundays when service is less frequent. In addition, some people may call the system and then decide not to make the trip or make alternate transportation arrangements. In this case the Telerider system registers the call but no transit trip is made.

The growth in Telerider usage demonstrates the public's acceptence of, and reliance on, automated stop-specific schedule information. The growth in system utilization indicates that a greater percentage of transit riders are making use of the system, particularly on Saturdays and Sundays when service is less frequent and transit schedules are not as well known. However, the question of what impact an automated schedule information system has on ridership remains unanswered. Analysis of the Mississauga data suggests that the impact is very small and that transit service and demographic changes are by far the most important determinants of transit usage.

The 1986 annual operating costs for the Telerider system have been estimated at $136,500 - $60,000 for telephone charges, $20,000 for hardware, $32,500 for software, and $24,000 for personnel. The total calls to the system for the years 1984 to 1986 are shown below:

Year	Total Telerider Calls	Missing Days
1984	1,424,825	- 2 weeks - transit strike
1985	1,354,898	- 5 weeks - transit strike/lockout
1986	1,566,209	- 5 weeks - installation of new ATIS-3 system

The transit strikes in 1984 and 1985, and the installation of the new Telerider system in the fall of 1986 resulted in lower than expected total annual calls. Adjusting the 1986 calls to reflect full service for the year, annual Telerider calls were estimated at 1,750,000. Thus the operating cost in 1986 was approximately 7.8¢ per call.

3.3.3 Kitchener Transit

Kitchener Transit provides service to the twin cities of Kitchener and Waterloo located in south-western Ontario. Public transit service to the area's 215,000 residents is provided on twelve bus routes, with annual ridership approaching 10 million revenue passengers. Automated schedule information was introduced to the area on February 1, 1982. The Telerider system, resident at Kitchener Transit, also serves the neighbouring cities of Guelph and Brantford.

Annual ridership and service statistics for Kitchener Transit are summarized in Exhibit 12. The Kitchener-Waterloo area has shown small but consistent population growth since 1980, averaging 1.8% per annum. Over the same period, service has increased 6.9%, or at an average annual rate of 1.35%, while ridership has shown an average annual growth rate of just under 3.2%. Per capita ridership has grown from 42.95 in 1980 to 47.85 rides per capita in 1985. This growth is partly attributable to the increase in revenue vehicle-kilometres as the expanded service attracts new riders to the system. To control for increased service levels and population growth, ridership may be expressed as revenue passengers per 1000 revenue vehicle-kilometres per 1000 population. In 1980 there were 9.06 passengers/1000 revenue vehicle-kilometres/1000 population, while the 1985 ridership was 9.08. This would tend to suggest that the growth in ridership has largely been in response to increases in service and growth in the service area population.

Exhibit 12

Kitchener Transit Annual Service and Ridership Statistics

Year	Revenue Passengers	% Chge	Revenue Veh-Kms	% Chge	Rev Pass / Veh-Km	Kitchener Pop'n	% Chge	Per Capita Ridership
1980	8,290,000		4,739,000		1.75	193,000		42.95
1981	8,413,404	1.49%	5,096,908	7.55%	1.65	193,900	0.47%	43.39
1982	8,964,721	6.55%	4,866,586	-4.52%	1.84	198,850	2.55%	45.08
1983	8,956,604	-0.09%	4,673,521	-3.97%	1.92	201,838	1.50%	44.38
1984	9,250,004	3.28%	4,832,020	3.39%	1.91	204,500	1.32%	47.04
1985	9,695,813	4.82%	5,067,143	4.87%	1.91	210,700	3.03%	47.85
1986	5,789,470		2,955,961					

Notes :

1. 1986 data is for January through July.
2. Average per annum growth rate 1980 - 1985 :
   - Ridership 3.18 %
   - Service 1.35 %
   - Population 1.77 %

To explore the impact of the automated schedule information system in greater detail, average daily ridership and Telerider utilization were analyzed. Exhibit 13 presents average weekday, Saturday and Sunday revenue passengers for the period January 1982 to July 1986. The seasonal variation in ridership is evident in the data displayed. Transit patronage is highest during the winter months, peaking in the period January through March. Ridership drops sharply in the summer months, due in part to the exodus of university students attending the University of Waterloo and Wilfred Laurier University. Weekday ridership in the winter months is in the 35,000 to 40,000 range, dropping to roughly 22,000 in July and August. Ridership is approximately 40% lower on Saturdays, with Sunday ridership only one tenth that experienced on weekdays.

Exhibit 14 has been prepared to investigate annual trends in weekday, Saturday and Sunday ridership. The annual data have been aggregated into four time periods to highlight the seasonal variations and dampen the effects of random fluctuations in ridership. Focusing on average weekly revenue passengers, ridership declined slightly in the first half of 1983, recovering to finish the year only slightly below 1982 levels. With the exception of the summer months, July and August, ridership grew sharply in 1984, followed by eight months of moderate growth until September 1985 when ridership again increased sharply. The observed trends in transit usage correspond closely with service changes. Two routes were combined in February 1983, followed by the elimination of another route in June and minor service increases in September. New routes were initiated in September 1984 and 1985.

Saturday and Sunday ridership has not increased significantly, relative to weekday ridership, following the introduction of Telerider. Saturday ridership has remained just under 11% of average weekly ridership while Sunday ridership accounts for roughly 2% of the average weekly revenue passengers.

EXHIBIT 13

KITCHENER TRANSIT

AVERAGE DAILY RIDERSHIP

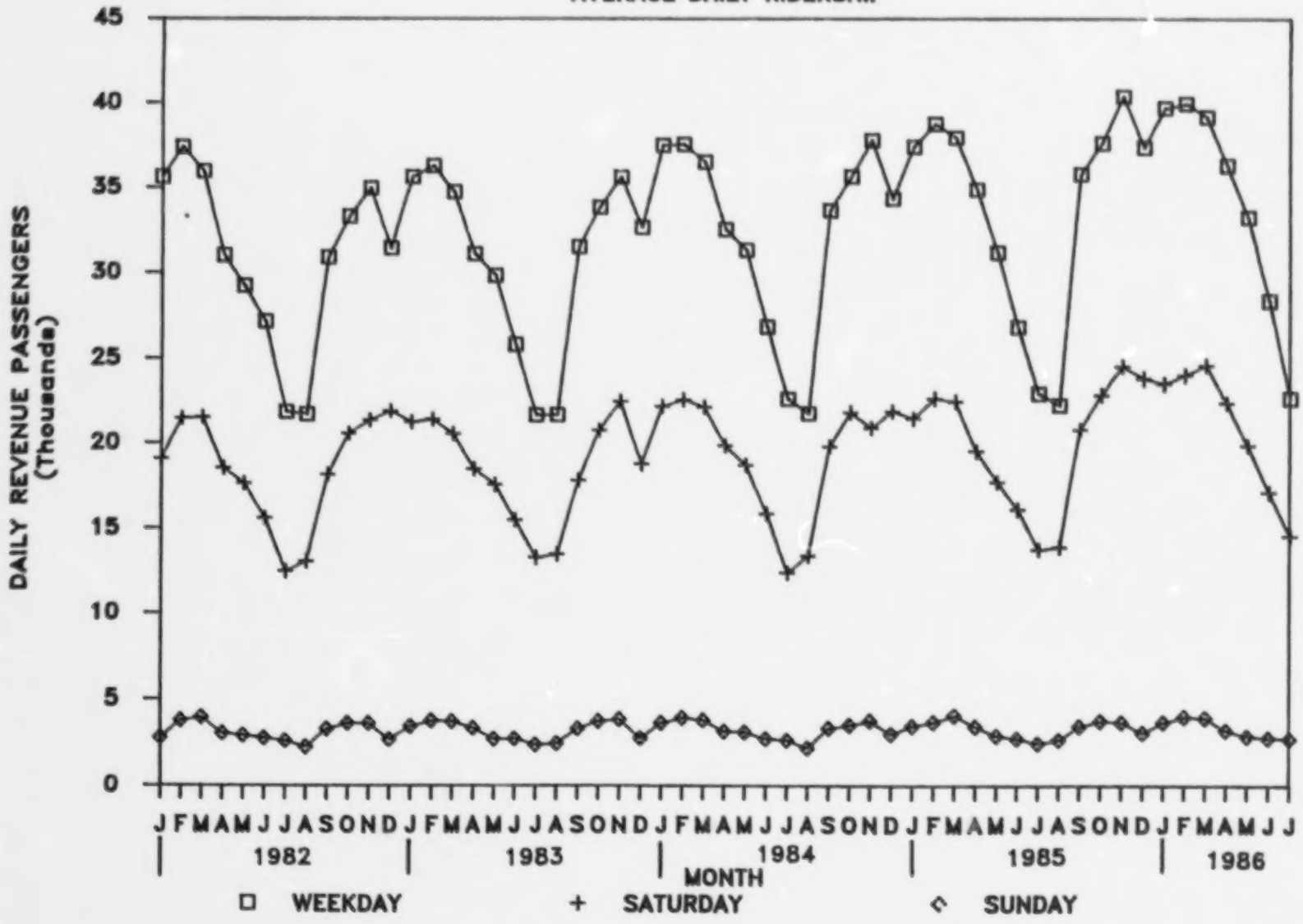


Exhibit 14

Kitchener Transit Average Daily Revenue Passengers : 1982 - 1986

January - March

Year	Average Daily Revenue Passengers						Weekly		%	%
	Wkday	% Cge	Sat	% Cge	Sun	% Cge	Average	% Cge	Sat	Sun
1982	36,350		20,725		3,519		202,473		10.2%	1.7%
1983	35,541	-2.2%	21,108	1.8%	3,665	4.2%	198,814	-1.8%	10.6%	1.8%
1984	37,181	4.6%	22,356	5.9%	3,806	3.8%	208,259	4.8%	10.7%	1.8%
1985	38,006	2.2%	22,244	-0.5%	3,767	-1.0%	212,274	1.9%	10.5%	1.8%
1986	39,575	4.1%	24,079	8.3%	3,898	3.5%	221,956	4.6%	10.8%	1.8%

April - June

Year	Average Daily Revenue Passengers						Weekly		%	%
	Wkday	% Cge	Sat	% Cge	Sun	% Cge	Average	% Cge	Sat	Sun
1982	29,131		17,249		2,926		162,906		10.6%	1.8%
1983	28,914	-0.7%	17,179	-0.4%	2,938	0.4%	161,749	-0.7%	10.6%	1.8%
1984	30,228	4.5%	18,162	5.7%	3,026	3.0%	169,302	4.7%	10.7%	1.8%
1985	30,952	2.4%	17,799	-2.0%	3,063	1.2%	172,559	1.9%	10.3%	1.8%
1986	32,631	5.4%	19,827	11.4%	3,007	-1.8%	182,984	6.0%	10.8%	1.6%

July - August

Year	Average Daily Revenue Passengers						Weekly		%	%
	Wkday	% Cge	Sat	% Cge	Sun	% Cge	Average	% Cge	Sat	Sun
1982	21,819		12,786		2,451		121,878		10.5%	2.0%
1983	21,717	-0.5%	13,395	4.8%	2,447	-0.1%	121,978	0.1%	11.0%	2.0%
1984	22,254	2.5%	12,895	-3.7%	2,453	0.2%	124,165	1.8%	10.4%	2.0%
1985	22,643	1.7%	13,835	7.3%	2,604	6.2%	127,050	2.3%	10.9%	2.0%

September - December

Year	Average Daily Revenue Passengers						Weekly		%	%
	Wkday	% Cge	Sat	% Cge	Sun	% Cge	Average	% Cge	Sat	Sun
1982	32,647		20,533		3,325		183,767		11.2%	1.8%
1983	33,414	2.4%	20,020	-2.5%	3,439	3.4%	187,092	1.8%	10.7%	1.8%
1984	35,347	5.8%	21,157	5.7%	3,440	.0%	197,890	5.8%	10.7%	1.7%
1985	37,758	6.8%	23,051	8.9%	3,523	2.4%	211,838	7.0%	10.9%	1.7%

Average daily Telerider utilization is displayed in Exhibit 15. The system is most heavily used during the winter months when the inclement weather makes waiting at bus stops more onerous and on Saturdays and Sundays when headways are longer and schedules are less well known. System usage, particularly on weekends, has grown significantly since Telerider was introduced in February, 1982. Annual calls to the system are summarized below:

Year	Annual Telerider Calls	Calls per 1000 Passengers	
1982	912,710	112	(Feb. - Dec.)
1983	1,455,419	162	
1984	1,965,852	213	
1985	2,045,254	211	
1986	1,341,608	232	(Jan. - July)

The initial capital cost of the Telerider system was $800,000, with Kitchener Transit assuming 54% of the cost and Guelph and Brantford sharing the remaining 46%. Amortizing Kitchener's capital cost over five years at 10% yields an annual capital cost of $114,000. Annual operating costs for 1985 were estimated to be about $65,000. Expressing the annual capital and operating costs on a per call basis yields a 1985 cost of 8.8¢ per call. The operating cost component is only 3.2¢/call, well below the 7.8¢/call estimated for the Mississauga system. The much heavier utilization of the Kitchener system is primarily responsible for the lower operating cost per call.

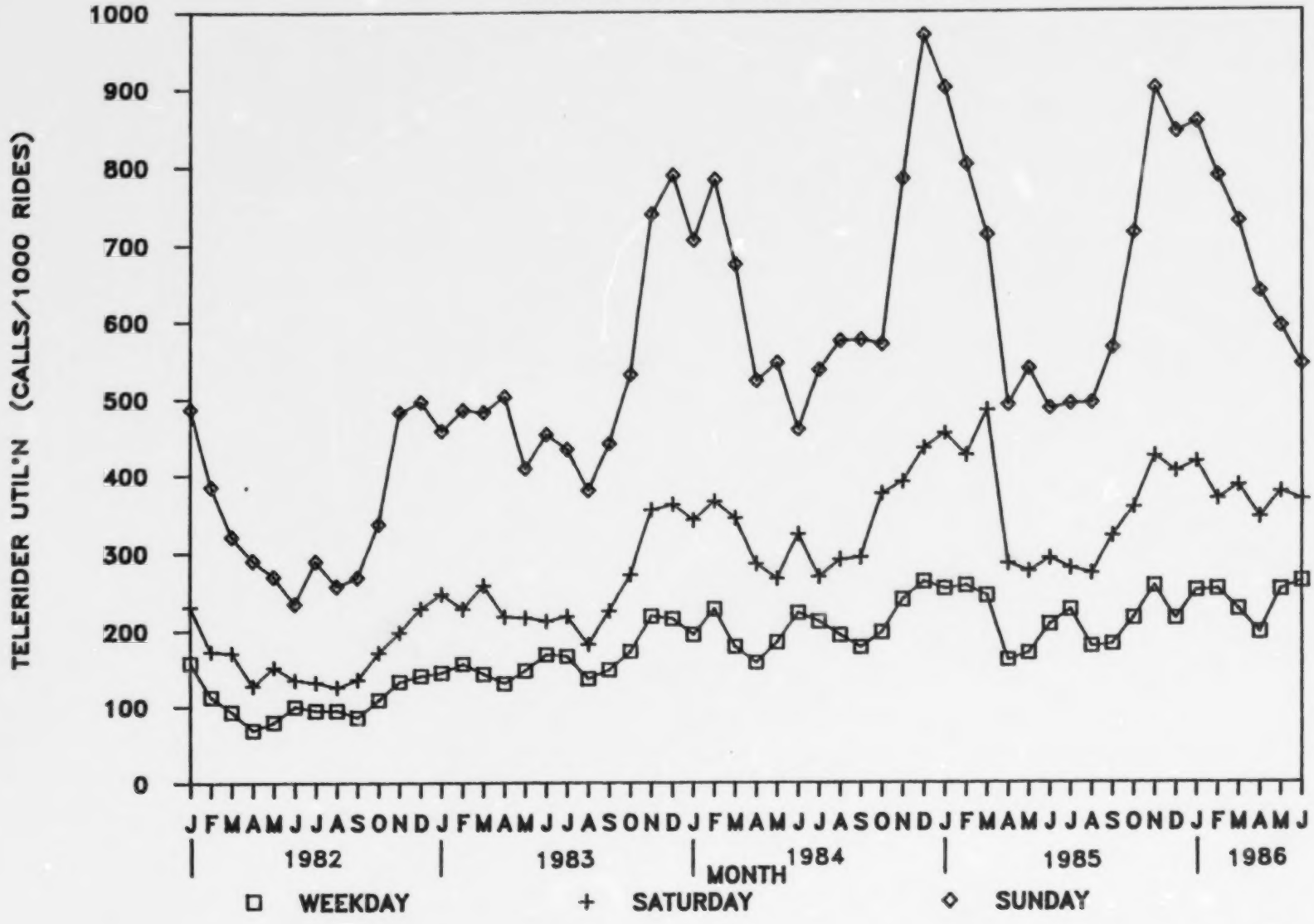
3.3.4 Guelph Transportation Commission

Guelph is a small city of 80,000, located just east of the twin cities of Kitchener and Waterloo. Public transit service to the area's residents is provided on 10 bus routes, operating on 30 minute headways from 6:15 a.m. to 11:30 p.m. Monday through Saturday. There is no Sunday service. The Telerider system, introduced in the summer of 1982, is part of the Kitchener system with special telephone connections giving Guelph residents access to the computer housed at the Kitchener Transit offices.

EXHIBIT 15

KITCHENER TRANSIT

AVERAGE DAILY TELERIDER UTILIZATION



The area has exhibited relatively small but stable growth since 1980. Over the period 1982 to 1985, growth in service area population has averaged 2.6% per annum. Transit service measured by annual revenue vehicle-kilometres, has grown at a rate of 3.1% per annum, with ridership increases averaging 3.5% per annum. Average daily ridership and Telerider utilization, summarized by month, is presented graphically in Exhibit 16 and 17, and tabulated in Exhibit 18. (Revenue passengers are estimated from ticket sales and cash fares collected, so it was not possible to accurately identify Saturday ridership separately). The most striking observation in the Guelph data is the extremely low Telerider utilization. This is emphasized in Exhibit 17 which shows that average daily calls to the system per 1000 revenue passengers has steadily declined from approximately 24 in 1982 to less than 10 in the first six months of 1986. This means that less than 1% of revenue passengers are using the automated schedule information system. This very low utilization may be rationalized by the small size of the transit system and the uniform service provided on all routes.

The cost effectiveness of the Telerider system may be investigated by comparing annual costs with total calls. The Guelph Transportation Commission budgeted $27,500 for operation of the Telerider system in 1985. The system received 33,429 calls in 1985, representing an operating cost per call of 82¢. Therefore, simply based on operating costs, the Telerider system in Guelph is a very costly method of providing the public with schedule information.

A detailed investigation of the Telerider system at Brantford Transit was not undertaken; however, preliminary analysis of the available data suggests that their system is only marginally more heavily utilized than Guelph's. The results of Brantford's annual ridership surveys are shown in Exhibit 19. Telerider utilization has dropped from the mid-50s in 1984 to approximately 20 calls per 1000 passengers in 1986. Given that Brantford Transit carried only about one-half the passengers in 1984 and 1985, their operating costs per call are probably in the same range as those at Guelph.

EXHIBIT 16

GUELPH TRANSPORTATION COMMISSION

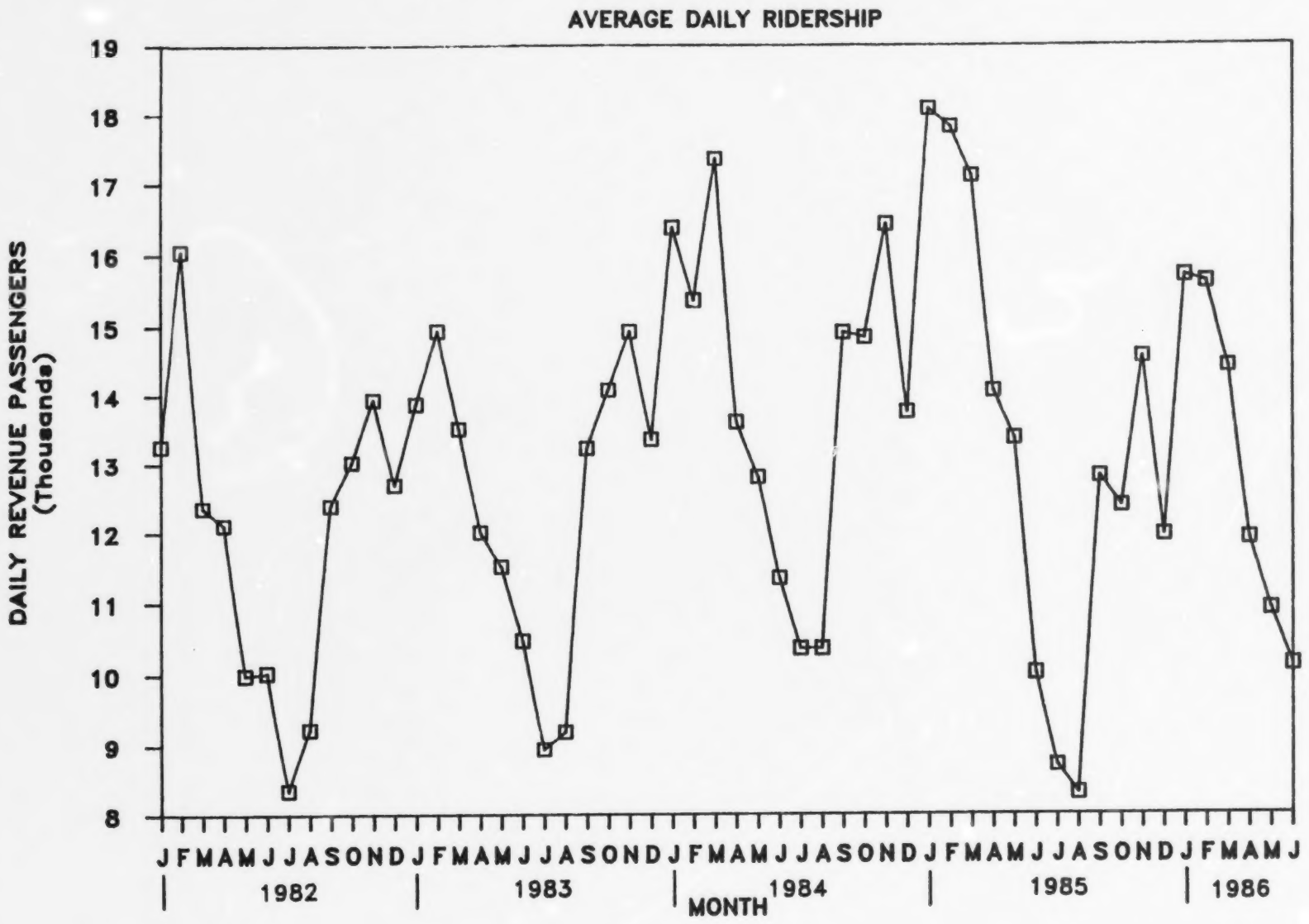


EXHIBIT 17

GUELPH TRANSPORTATION COMMISSION

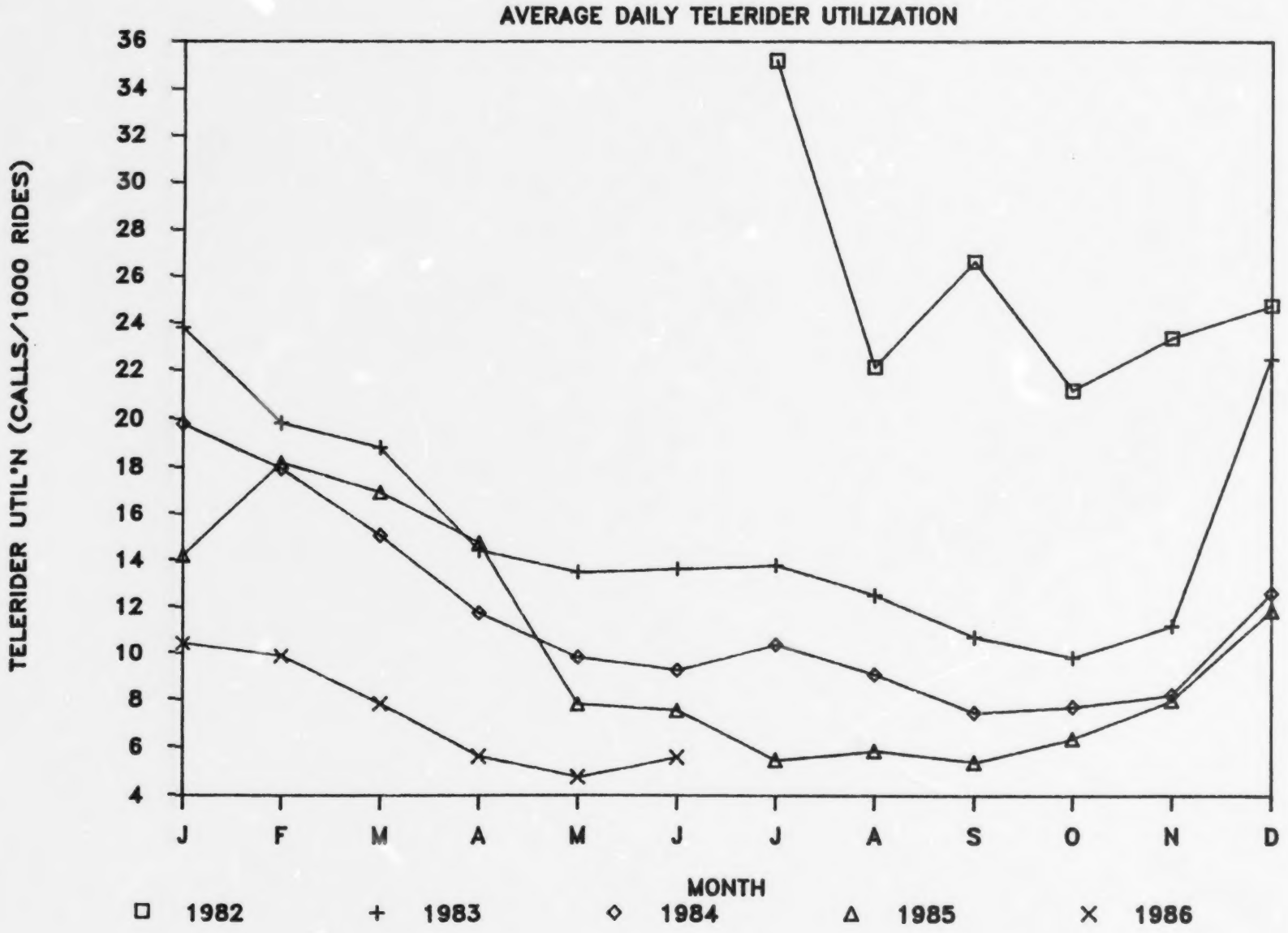


Exhibit 18

Guelph Ridership and Telerider Utilization

Mo/Yr	Fare Pass.	Service Days	Avg. Dly Pass.	Telerider Usage Calls	Days	Avg.	Calls / 1000 Rdrs.
Jan '82	344,932	26	13,267				
Feb	385,347	24	16,056				
Mar	333,738	27	12,361				
Apr	302,829	25	12,113				
May	249,922	25	9,997				
Jun	260,803	26	10,031				
Jul	216,943	26	8,344	7,640	26	294	35
Aug	230,811	25	9,232	3,676	18	204	22
Sep	309,777	25	12,391	7,918	24	330	27
Oct	325,784	25	13,031	6,056	22	275	21
Nov	362,204	26	13,931	7,800	24	325	23
Dec	330,093	26	12,696	7,850	25	314	25
Jan '83	346,704	25	13,868	6,275	19	330	24
Feb	358,431	24	14,935	6,817	23	296	20
Mar	364,768	27	13,510	6,612	26	254	19
Apr	300,218	25	12,009	4,513	26	174	14
May	288,017	25	11,521	3,273	21	156	14
Jun	272,355	26	10,475	3,293	23	143	14
Jul	223,656	25	8,946	3,089	25	124	14
Aug	239,150	26	9,198	1,725	15	115	13
Sep	330,808	25	13,232	2,552	18	142	11
Oct	351,903	25	14,076	2,490	18	138	10
Nov	387,959	26	14,922	4,514	27	167	11
Dec	347,321	26	13,359	7,787	26	300	22
Jan '84	425,673	26	16,372	6,484	20	324	20
Feb	383,981	25	15,359	6,068	22	276	18
Mar	468,551	27	17,354	5,759	22	262	15
Apr	340,106	25	13,604	2,080	13	160	12
May	332,987	26	12,807	3,024	24	126	10
Jun	295,190	26	11,353	2,743	26	106	9
Jul	259,205	25	10,368	2,477	23	108	10
Aug	269,584	26	10,369	2,167	23	94	9
Sep	357,599	24	14,900	2,560	23	111	7
Oct	385,648	26	14,833	2,979	26	115	8
Nov	426,780	26	16,415	3,383	25	135	8
Dec	343,605	25	13,744	3,635	21	173	13

Exhibit 18 (Cont'd)

Guelph Ridership and Telerider Utilization

Mo/Yr	Fare Pass.	Service Days	Avg. Dly Pass.	Telerider Usage Calls	Days	Avg.	Calls / 1000 Rdrs.
Jan '85	470,284	26	18,088	5,408	21	258	14
Feb	427,863	24	17,828	7,141	22	325	18
Mar	444,757	26	17,106	6,957	24	290	17
Apr	365,325	26	14,051	1,869	9	208	15
May	347,557	26	13,368	1,673	16	105	8
Jun	250,690	25	10,028	1,366	18	76	8
Jul	226,244	26	8,702	859	18	48	5
Aug	215,806	26	8,300	1,022	21	49	6
Sep	307,552	24	12,815	1,247	18	69	5
Oct	321,916	26	12,381	1,660	21	79	6
Nov	378,242	26	14,548	2,097	18	117	8
Dec	299,214	25	11,969	2,130	15	142	12
Jan '86	408,018	26	15,693	2,292	14	164	10
Feb	374,619	24	15,609	2,933	19	154	10
Mar	360,219	25	14,409	2,486	22	113	8
Apr	309,854	26	11,917	1,543	23	67	6
May	283,732	26	10,913	1,304	25	52	5
Jun	253,468	25	10,139	1,363	24	57	6

Exhibit 19

Brantford Transit Annual Ridership Survey Results

Year	Date	Revenue Passengers	Telerider Calls	Calls per 1000 Pass.
1984	Tuesday March 20	7,846	450	57.4
	Thursday March 22	7,779	385	49.5
	Friday March 23	8,829	517	58.6
1985	Tuesday March 19	7,678	304	39.6
	Thursday March 21	7,944	191	24.0
	Friday March 22	8,369	212	25.3
1986	Tuesday March 4	6,872	119	17.3
	Thursday March 6	6,647	150	22.6
	Friday March 7	6,782	-	-

3.3.5 U.S. Telerider Experience

Teleride currently has three automated schedule information systems operating in the U.S. The Telerider system has been operating system-wide in Columbus, Ohio since 1983. The Utah Transit Authority (Salt Lake City) and the Port Authority of Allegheny County (Pittsburg) have recently completed Telerider demonstrations and are evaluating the results before making a decision on system-wide implementation.

The Utah Transit Authority (UTA) implemented Telerider on six test routes on February 4, 1983. Information was gathered on system impacts throughout a sixteen-month demonstration period, which included two system effectiveness tests of six months each separated by four additional months of system operation. During the sixteen-month analysis period, UTA's total daytime bus patronage grew at an average annual rate of one percent. Compared with these system-wide trends, ridership on the Telerider test routes decreased 0.1% overall, while an increase of 3.2% occurred on the six control routes. The UTA Board considered these results to be inconclusive since the differences were not statistically different at the 95% confidence level.

The importance of a number of potential causal factors affecting bus ridership was studied statistically during the system evaluation. These factors included the local unemployment rate, temperature, bus fares, gasoline costs, seasonal variables, trends over time, and the existence of the Telerider system. The results indicated that ridership levels on the test and control routes were not significantly related either to the existence of the Telerider system or to the number of calls to the system. Conversely, each of the other variables listed above, with the exception of the price of gasoline, were significant determinants of ridership levels.

A study of system utilization at the end of the sixteen-month demonstration revealed there were 17 calls to the Telerider system per 1000 passengers. This rate varied in a relatively narrow range for the six test routes, with the more lightly travelled routes tending to have the higher call

rates. It was also discovered that the manual customer information service was receiving more schedule information calls for the test routes than the automated system - 57% versus 43%.

The one quantifiable benefit attributed to the automated schedule information system was a reduction in calls to the customer service department. In both 1982 and 1983, customer service inquiry rates for the Telerider test routes did not significantly differ from those for other routes having similar characteristics with respect to route length, trips per day, and express services. In 1984, the average rate of calls to the customer service operators for information on the test routes was only two-thirds of the average rate for UTA's control routes. While the data were not sufficient to establish the impact as statistically significant, the Telerider system apparently did have an impact on the need for customer service operators to serve users of the test routes.

In their assessment of benefits from a Telerider system serving all routes, the UTA estimated that the Customer Service Department could reduce its annual costs for staff and equipment by $167,300. The full operating cost reduction was expected to be achieved after the system had been operating for five years.

The UTA combined each of the one-time and continuing costs and benefits identified in their analysis and estimated the net present value of a complete Telerider system in Salt Lake City. Using an interest rate of 10 percent to discount future costs and benefits, assuming a ten-year system life and expressing all dollar values in terms of 1983 dollars, the system was found to have a net cost of $891,000. Sensitivity tests indicated that major changes in the assumptions underlying the economic analysis would be required to increase the net present value to zero. For example, system-wide ridership would have to increase 492,000 passengers per year, 3.2 percent of the existing ridership, for the project to have a NPV of zero.

Thus, based on the consideration of all quantifiable costs and benefits, the Salt Lake City Telerider system does not represent a cost-effective investment of funds.

The UTA Board's decision to proceed with a full system-wide implementation of Telerider indicates that they felt other benefits justified the costs of a complete system.

The Port Authority of Alleghany County (PAT) initiated a Telerider demonstration in the North Hills area of Pittsburg in August of 1985. Telerider is now operating on 54 routes, approximately 30% of the area's transit system. The system is now undergoing an evaluation by the Port Authority Planning Department and UMTA.

In addition to the standard benefits expected from the automated schedule information features of Telerider-improved information dissemination, reduced demands on the existing telephone information system, and increased ridership, PAT has suggested a number of other features which it regards as having equal or greater benefits. These include: a computerized record of all on-road maintenance problems and other occurrences which are summarized into reports useful to various departments, an up-to-date, easily maintained data base of all bus stop, a capability for all public information operators to access both the record of occurrences and the bus stop file for use in answering requests for information, and a computer which, with minor expansion, can run a new computer assisted scheduling system. PAT hopes to save $100,000 annually by switching to computerized scheduling from the current manual procedure.

The system has been operating for more than a year now and there has been no ridership increase in the North Hills area that can be directly attributed to the automated schedule information system. Monthly ridership and Telerider calls for the first six months of 1986 are shown below:

Month	Ridership	Telerider Calls	Calls per 1000 Rides
Jan.	1,368,486	16,358	12
Feb.	1,260,420	14,981	12
March	1,455,382	18,063	12
April	1,460,637	15,491	11
May	1,433,747	17,642	12
June	1,393,785	15,262	11
July	1,431,771	15,171	11

Telerider utilization is very low, with just over one percent of the transit patrons in North Hills using the automated schedule information system.

The preliminary results from Pittsburg are similar to those found in Salt Lake City. If the Port Authority proceeds with expansion of the Telerider system to all routes, it will probably have to be justified on the basis of benefits other than those which can be strictly quantified.

4. Conclusions

4.1 Computer Assisted Information Systems

Marketing in the field of public transportation generally focuses on improving the public's perception of transit or disseminating information to potential users in an effort to stimulate demand and make it easier to use the transit system. As one of the marketing methods available, telephone information systems are readily accessible to a substantial portion of the general public and can be quickly and easily updated to reflect changes in services. Moreover, telephone information services can be personalized to suit the needs of the individual customer.

Virtually all transit authorities provide telephone information services to assist passengers in making the best use of the transit system. However, increased awareness of the importance of effective public transit marketing has resulted in efforts to improve telephone information systems to compensate for the labor intensive and high cost characteristics of the traditional manual means of communication. In particular, advances in computer technology have raised the potential for automating a number of the information functions previously performed manually.

The two computer assisted information systems reviewed in this report utilize the high-speed calculating capabilities of the computer to store, manipulate and retrieve transit network and service area data. The information system functions much the same as traditional manual systems, except that information agents rely on the computer to provide information rather than searching hard-copy references. The basic objectives of these computer programs are to increase agent productivity, improve the working environment, reduce overall information system operating costs and improve service offered to the travelling public.

The experiences of the Washington Metropolitan Area Transit Authority and the Southern California Rapid Transit District were generally encouraging. A ten to fifteen percent increase in agent productivity was

realized with the new system. The majority of information agents adapted well to the computerized system and felt that it enhanced their job satisfaction. The implication, yet to be demonstrated, is that this will lower the high agent turnover rate experienced in the information section. Increased consistency and greater response accuracy with the new system was acknowledged by almost all individuals.

The reduction of information system operating costs was one objective which was not fully realized with computerized information storage and retrieval. The decision to retain hard-copy reference data as a back-up to the computerized system did not result in the anticipated cost savings due to centralized data base updating. In addition, the increase in agent productivity was less than initially expected. Both transit authorities are, however, confident that productivity will increase gradually as agents become more familiar with the computer system. Finally, reinstatement of the original 6-week training period for new agents at WMATA did not produce the expected training cost reductions. The SCRTD, on the other hand, shortened their original 8-week training period to 4-weeks and were, therefore, able to significantly reduce their training costs.

One area where conflicting results were achieved concerns training time reduction. The conclusion that can be drawn from the two experiences is that the computerized system provides the transit property with the option of reducing training requirements and thereby expanding agent selection capabilities. On the positive side, training time and costs can be reduced significantly, older individuals, who have been found to be more dependable, may be employed, and inclusion of part-time employees can give management greater flexibility in scheduling of personnel. On the negative side, reduced training of new agents forces them to rely more heavily on the automated system since their knowledge of the transit system and use of available hard-copy references is limited. Their reliance on the computer for simple fare and schedule requests, better handled manually or from memory, limits their ultimate productivity. The SCRTD felt the benefits from reduced training requirements more than offset the

disbenefits, whereas WMATA opted to stay with the original training period and use the computerized system to achieve further productivity increases.

It is difficult to quantify all the benefits associated with a computerized data storage and retrieval system as evidenced by the fact that neither transit property attempted to conduct a detailed cost benefit analysis of the new system. An excellent example of this difficulty relates to the assessment of the impact of increased job satisfaction. While both properties implied that the improved working environment would translate into more stable and dependable employment records among their information agents, they were unable to quantify effects in terms of reduced operating costs.

A follow-up study on the Washington system demonstrated a net contribution to the Authority's revenue from operation of the telephone information service. The analysis did not, however, include the capital cost of the computerized system ($1,635,000) nor did it attempt to compare revenue generated with the new system to what might have been generated from the previous manual system.

A number of general conclusions can be drawn concerning the basic criteria necessary for a computer assisted information system to be considered for implementation. The system's main feature is its computerized routing algorithms; therefore, the demand for itinerary planning information must be very high. In WMATA's case, two-thirds of their information requests were of this type. While there are economies of scale, the basic capital cost components - hardware, software and data base development - certainly argue for a large, complex multi-modal transit system. Finally, the information system must be heavily used to justify the large capital expenditures. This implies operation for most, if not all, of the day. In the case of Washington, the system was operational 18 hours a day while the SCRTD operated 24 hours a day, 365 days a year.

In summary, WMATA and the SCRTD are satisfied that the overall benefits of a computerized information storage and retrieval system outweigh the additional costs incurred. Any transit authority contemplating such a system should carefully assess their current operations in light of the above mentioned criteria before embarking on system-wide implementation since both the capital and additional operating costs of such a system can be substantial.

4.2 Automated Schedule Information Systems

In contrast to WMATA and SCRTD, where the emphasis is on reducing the cost of information systems through automation, automated schedule systems place more emphasis on the use of automation as a means of increasing ridership and revenue by reducing some of the uncertainty associated with waiting time at bus stops. Some of these systems provide this information on a "real time" basis, whereas others provide only regular or updated schedule information.

Automated schedule information systems, such as the one marketed by Teleride Corporation, are fully automated systems which provide schedule and other service information to the general public. A caller identifies the queried stop by the last four digits dialed, and the computer generates a voice response with scheduled arrival times for routes serving the requested bus stop. The basic objective of the automated telephone system is to improve a transit authority's information dissemination and increase the attractiveness of public transit. The rationale behind the provision of stop-specific schedule information is to greatly reduce one of the most important deterrents to using public transit, namely, waiting time at bus stops, particularly when such waiting becomes lengthly, uncertain, or takes place in poor weather or at night.

The provision of stop-specific transit schedule information in this easily accessible manner has been promoted as a cost-effective means of increasing ridership. The system also offers a transit authority other

potential benefits. Because the system is fully automated and focuses on only one specific information request, it can provide the information faster and at a more detailed level than by manual means. This not only provides a better service to those requesting schedule information, but frees up the traditional telephone information service to answer more complex routing and itinerary planning requests.

Since its introduction in the late 1970s, the Teleride system has been installed at a number of Canadian and U.S. public transit authorities. Evaluation of the Telerider system in this report focused on the experiences of four Canadian and two U.S. transit properties. Analysis of ridership data from the various properties consistently found no increase in ridership that could be attributed to the automated schedule information system. Given that the expected increase is only in the order of three to five percent, this is not surprising. The consistency in the results would, however, appear to indicate that if there is an increase in ridership, it is very small. The consistently strong correlation between ridership and transit service (i.e., revenue vehicle-kilometres) and service area population reinforced their overriding impact on transit usage.

The wide variation in Telerider utilization (i.e., calls per 1000 revenue passengers) was found to be somewhat related to the size of the transit system and the extent of Telerider coverage. This was most evident with the smaller transit properties, Guelph and Brantford, and the two Telerider demonstrations in the U.S. In the smaller Canadian properties, Telerider utilization is very low, with only 10 to 20 calls to the system for every 1000 revenue passengers. The Guelph Telerider system has shown consistent decline in usage since its introduction in the summer of 1982. At present, less than one percent of revenue passengers use the system. This is obviously not a cost effective means of providing schedule information, as Telerider operating costs, expressed on a per call basis, are 82¢/call, roughly twice the revenue generated by the rider. It would appear that individuals in smaller urban areas (of less than 100,000 population) have little need for stop-specific schedule information, presumably because the simple transit

networks have few routes and provide a very regular, although infrequent, service which is well known to the inhabitants.

The low Telerider utilization at the two U.S. transit properties, in the range of 10 to 20 calls per 1000 revenue passengers, was attributed to the limited system coverage - 10 routes in Salt Lake City and 30 percent of the service area in Pittsburg. Even accepting this argument, the Telerider system does not appear to be economically justifiable unless a ten-fold increase in usage could be expected from system-wide implementation. Such an increase seems highly unlikely.

The Telerider system is more heavily used at the large Canadian transit authorities: Mississauga Transit, Kitchener Transit and Winnipeg Transit. Telerider has been operational for less than a year at Winnipeg Transit so results to date are not truly representative of long-term system usage. Average daily utilization is low in comparison to utilization experienced by Mississauga and Kitchener. One plausible explanation is that larger transit systems provide more frequent service and greater service area coverage, which reduces the need for schedule information. It was not possible to explore this hypothesis with the Telerider data from Winnipeg as call summaries were not route-specific, and therefore, no correlation between call frequency and service headway could be established.

Trends in Telerider utilization at Mississauga and Kitchener were very similar. Average daily utilization is highest on weekends, particularly on Sundays and holidays, and there are obvious seasonal variations, with utilization increasing sharply during the winter months. The Kitchener system demonstrates significantly heavier usage: comparing total calls to Telerider with annual ridership in 1985, the Kitchener system averaged 211 calls per 1000 revenue passengers compared to an average of 110 at Mississauga.

The lack of consistent capital and operating costs for the Telerider system restricts any systematic analysis of costs between the various transit

properties. On a cost per call basis, operating costs were found to vary widely, from 3.2¢/call at Kitchener to 7.8¢/call at Mississauga, and 82¢/call at Guelph. The wide variation is more reflective of system utilization, as operating costs are largely independent of system usage. While it is a political judgement as to what is an acceptable operating cost for the automated schedule information system, it is obvious that it is not effective when operating costs exceed those of a manual telephone information service. This would appear to be the case at the Guelph Transportation Commission.

Exhibit 20 shows Telerider costs in relation to service area size. In this exhibit, capital costs are presented relative to service area population at the time of system implementation, while operating costs are compared with current population estimates. The capital and operating cost ratios are relatively stable across properties. Capital costs vary from $2.20 to $2.40 per capita, while annual operating costs are in the range of 30¢ to 40¢ per capita. While these ratios are understandably very crude, they serve as a measure of costs for any transit authority contemplating installation of an automated schedule information system.

As a final comment, it should be noted that many of the automated schedule information systems were originally introduced as demonstration projects. Presumably, the purpose of the demonstration was to show either how information system costs could be reduced or how automated systems could generate additional ridership, or both. During the demonstration periods, however, it appears that little data were collected on a route specific basis to allow for any statistical analysis of the correlation between use of the automated system and increases in ridership, particularly during periods of low frequency service (i.e., off-peak) when, intuitively, one would expect automated systems to be most useful. Nevertheless, despite any substantive correlation between benefits and costs, many transit authorities appear to be adopting automated passenger information systems as a standard feature of their services.

4.3 Summary Conclusions

Despite the relatively scant information available for a systematic analysis of the impacts of automation on either the costs of information systems or on the generation of additional ridership, it is possible to suggest a number of guidelines that might be followed in future applications of this type of technology:

1. Computer assisted systems used to supplement manual information systems should be evaluated in terms of their primary contribution to cost reduction, that is, as a means of increasing operator productivity. The basic issues to be considered relate to the extent to which these improvements in productivity allow more calls to be handled at a given level of expenditure (by requiring fewer lines and operators) and the extent to which they reduce the service time per caller (thereby encouraging greater use of the service).

2. Automated schedule information systems should be considered only for routes with modest to low frequency of service where long waiting times are seen to be a deterrent to potential ridership. These systems should probably not be considered for application to routes characterized by high frequency service where waiting times average less than 7.5 minutes (that is 15-minute scheduled headways).

3. As a corollary of 2, above, even for large systems involving multi-modal services, automated schedule information systems should be applied on a selective basis rather than a system-wide basis to meet these criteria.

4. In terms of contribution to increased ridership and revenue, automated schedule information systems should be integrated with vehicle monitoring systems so as to provide "real time" as opposed to schedule arrival information. The integration of these two systems, of course, provides additional benefits related to operational efficiency and flexibility for service adjustments such as short-turning.

5. Because the cost-effectiveness of automated schedule information systems in generating additional revenue has yet to be clearly demonstrated, the introduction of such systems should also be assessed in terms of other benefits and possibilities for cost reduction, including those related to vehicle maintenance and scheduling, and reductions in the costs of passenger information services (recognizing that separate but less extensive services will still be required for route planning information).

Exhibit 20

Telerider Capital and Operating Costs

Property	Year of Installation	Capital Cost	Service Area Population	Annual Operating Costs	1985 Service Area Population	Capital Cost per Capita	Operating Cost per Capita
Guelph	1982	$ 184,000	77,000	$ 27,500	80,000	$2.39	$0.34
Brantford	1982	$ 184,000	82,000	-	73,000	$2.24	-
Kitchener	1982	$432,000	199,000	$ 65,000	211,000	$2.17	$0.31
Mississauga	1982	-	313,000	$136,500	349,000	-	$0.39
Winnipeg	1986	$1,300,000	579,000	-	579,000	$2.25	-

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Centre de développement
des transports
Complexe Guy-Favreau
200 ouest, boul. Dorchester
Suite 601, tour ouest
Montréal, Québec
H2Z 1X4

Transportation
Development Centre
Guy Favreau Complex
200 Dorchester Blvd. West
Suite 601, West Tower
Montreal, Quebec
H2Z 1X4